ZOOM
TECHNOLOGIES

CCNA | Cisco Certified Network Associate

Lab Manual

CCNA

(Cisco Certified Network Associate)

Certification Mapped Course

Routing and Switching

Lab Manual

Introduction

This lab manual is designed as a practical supplement to the concepts taught in the CCNA mapped Routing and Switching course at Zoom Technologies India Pvt. Ltd.

We have included lab exercises on all the topics covered in the CCNA mapped course. The lab manual has been revamped and redesigned to make it very easy for the student to easily work out the task. We have also added a challenge lab at the end, to give the student a feel of the practical aspects of the CCNA exam.

Each of the exercises is divided into the five sections:

1. Objective
2. Topology
3. Tasks
4. Configuration
5. Verification

The lab manual leads the students from the basic initial configuration of a router to advanced topics like inter-vlan routing, OSPF- multi area configuration, EIGRP fine tuning, password recovery, etc.

We hope that this lab manual would be helpful to the students in solidifying their foundation in WAN networking. Any feedback or suggestions to improve this would be gratefully accepted.

Table of Contents

EXERCISE 1: BINARY TO DECIMAL CONVERSION

128	64	32	16	8	4	2	1	ANSWER IN DECIMAL	SCRATCH AREA
1	0	0	1	0	0	1	0		
1	1	0	0	0	0	0	0		
1	0	1	0	1	0	0	0		
0	1	0	0	0	0	0	0		
0	0	0	0	1	0	1	0		

EXERCISE 2: DECIMAL TO BINARY CONVERSION

DECIMAL	ANSWER IN BINARY								SCRATCH AREA
	128	64	32	16	8	4	2	1	
167									
63									
17									
24									
254									

EXERCISE 3: ADDRESS CLASS IDENTIFICATION

ADDRESS	CLASS
126.10.1.1	
128.10.1.1	
162.78.1.10	
39.255.255.255	
220.1.1.10	

EXERCISE 4: NETWORK AND HOST IDENTIFICATION BASED ON CLASS OF ADDRESS

CIRCLE THE NETWORK PORTION OF BELOW ADDRESSES	CIRCLE THE HOST PORTION OF BELOW ADDRESSES
132.12.1.1	161.43.5.6
128.10.1.1	13.1.100.254
176.13.10.10	202.153.32.121
162.78.1.10	100.140.2.230
200.1.1.1	171.24.100.10

EXERCISE 5: DEFAULT SUBNET MASK

ADDRESS	CLASS
126.10.1.1	
128.10.1.1	
162.78.1.10	
52.255.255.255	
220.1.1.10	

EXERCISE 6: NETWORK ADDRESS

USING THE IP ADDRESS AND SUBNET MASK SHOWN, WRITE THE NETWORK ADDRESS

IP ADDRESS AND SUBNET MASK	NETWORK ADDRESS
121.12.1.1 255.0.0.0	
175.13.10.10 255.255.0.0	
200.1.10.1 255.255.255.0	
119.0.255.20 255.0.0.0	
191.168.1.10 255.255.0.0	

EXERCISE 7: BROADCAST ADDRESS

USING THE IP ADDRESS AND SUBNET MASK SHOWN, WRITE THE BROADCAST ADDRESS

IP ADDRESS AND SUBNET MASK	BROADCAST ADDRESS
161.43.5.6 255.255.0.0	
13.1.100.254 255.0.0.0	
202.153.32.121 255.255.255.0	
100.140.2.230 255.0.0.0	
171.24.100.10 255.255.0.0	

EXERCISE 8: CISCO SLASH NOTATION

SLASH NOTATION	SUBNET MASK
/29	
/22	
/12	
/25	
/18	

EXERCISE 9: CUSTOM SUBNET MASK (SUBNETTING)

PROBLEM : 1	
Number of needed subnets	14
Network Address	200.10.10.0
Address class	
Default subnet mask	
Custom subnet mask	
Total number of subnets	
Total number of host addresses	
Number of usable addresses	
Number of bits borrowed from the host portion	

PROBLEM : 2	
Number of needed usable hosts	60
Network Address	171.10.0.0
Address class	
Default subnet mask	
Custom subnet mask	
Total number of subnets	
Total number of host addresses	
Number of usable addresses	
Number of bits borrowed from the host portion	

PROBLEM : 3	
Network Address	138.25.0.0/26
Address class	
Default subnet mask	
Custom subnet mask	
Total number of subnets	
Total number of host addresses	
Number of usable addresses	
Number of bits borrowed from the host portion	

PROBLEM : 4	
Number of needed subnets	2000
Network Address	111.0.0.0
Address class	
Default subnet mask	
Custom subnet mask	
Total number of subnets	
Total number of host addresses	
Number of usable addresses	
Number of bits borrowed from the host portion	

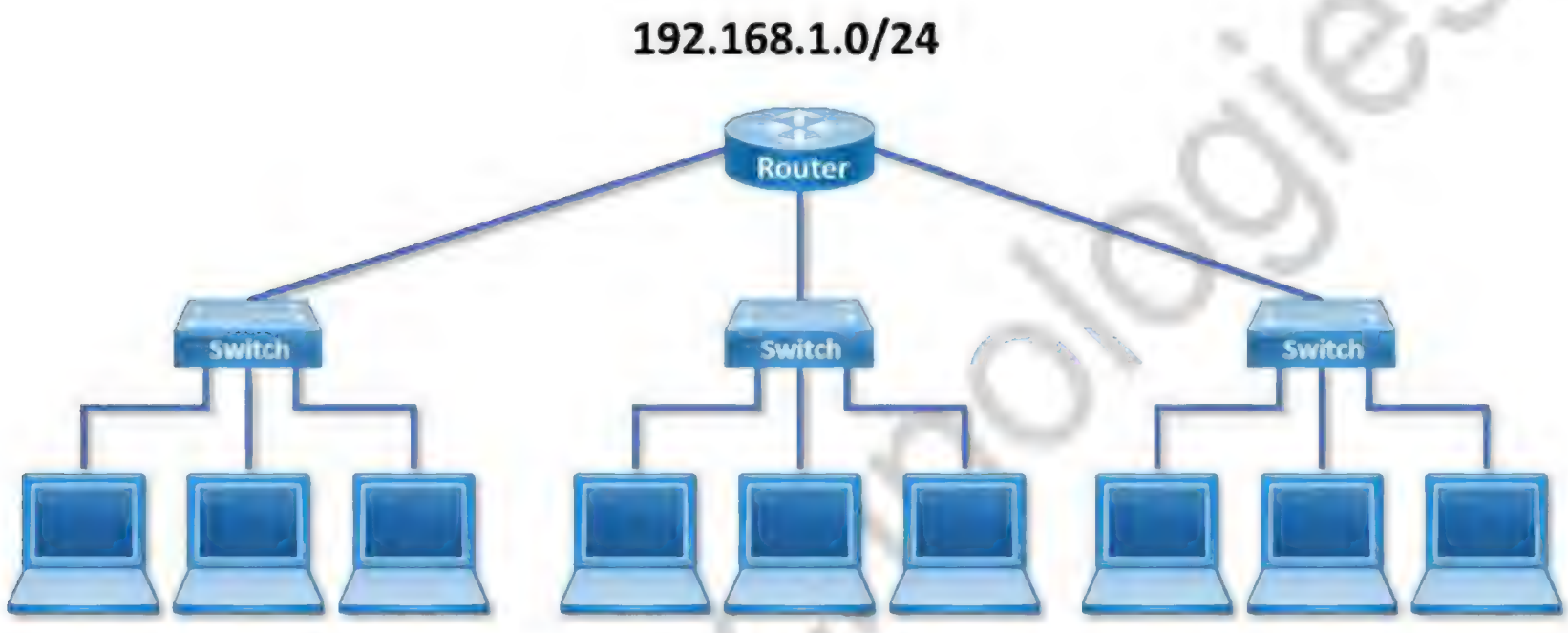
PROBLEM : 5	
Number of needed usable hosts	1000
Network Address	165.34.0.0
Address class	
Default subnet mask	
Custom subnet mask	
Total number of subnets	
Total number of host addresses	
Number of usable addresses	
Number of bits borrowed from the host portion	

PROBLEM : 6	
Network Address	192.100.1.0/29
Address class	
Default subnet mask	
Custom subnet mask	
Total number of subnets	
Total number of host addresses	
Number of usable addresses	
Number of bits borrowed from the host portion	

EXERCISE 10: VARIABLE LENGTH SUBNET MASK (VLSM)

PROBLEM: 1

The administrator gave the networking team 192.168.1.0/24 to use for addressing the entire network. After subnetting the address, the team is ready to assign the addresses



PROBLEM: 2

The administrator gave the networking team 192.168.164.0/24 to use for addressing the entire network. After subnetting the address, the team is ready to assign the addresses. The administrator plans to configure ip subnet-zero and use RIP v2 as the routing protocol. As a member of the networking team, you must address the network and at the same time conserve unused addresses for future growth.

LAB 1: INITIAL CONFIGURATION OF ROUTER

OBJECTIVE:

To get familiarized with Cisco IOS modes and configure a new Router with basic configuration i.e. assign IP address on the interfaces and configure passwords etc.

TOPOLOGY:

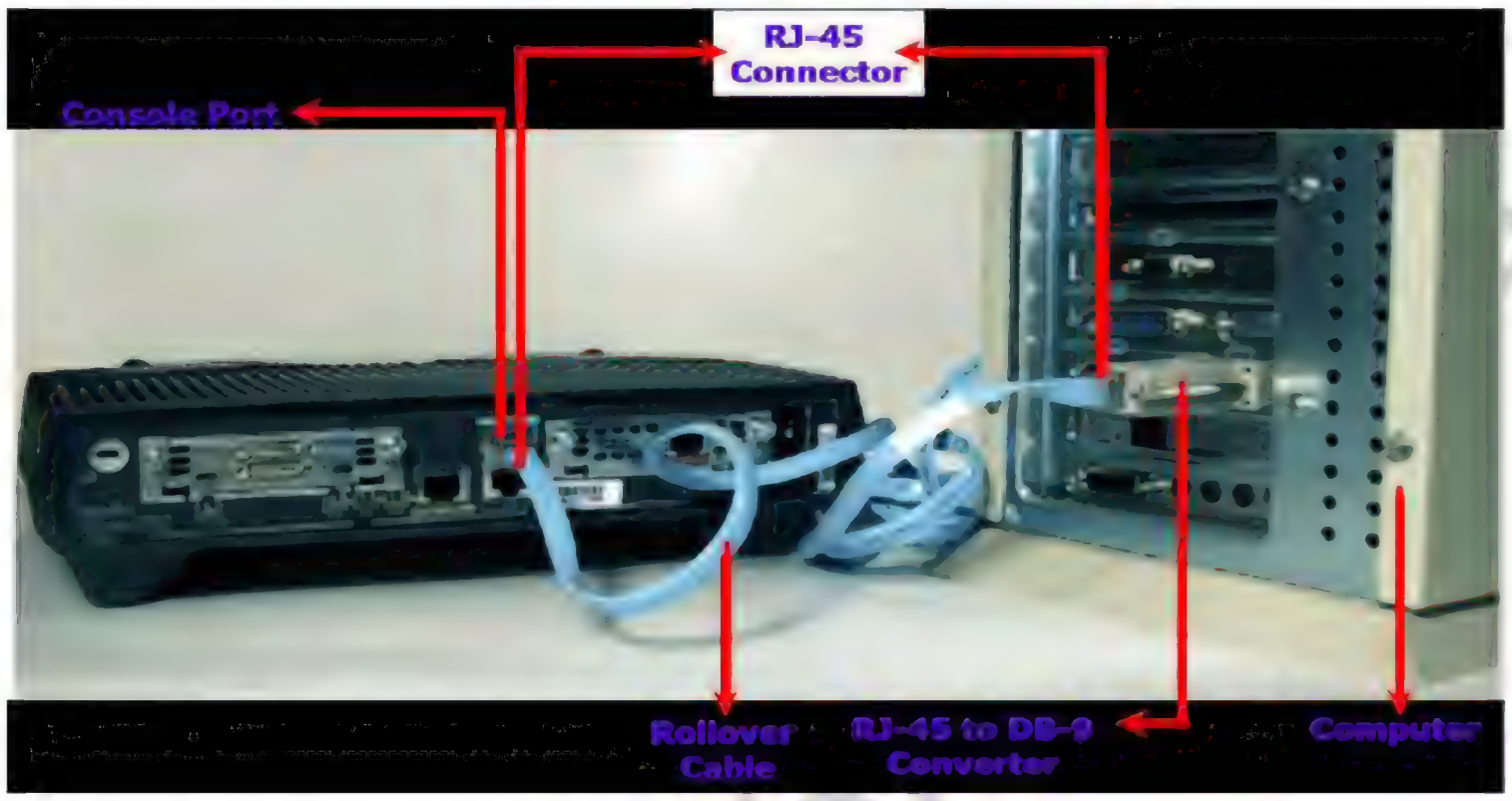
Setup Console and Ethernet connectivity for the lab as below :

TASK:

- Establish console connectivity
- Access router via console with an emulation software
- Get to know Cisco IOS Modes and Show commands
- Configure Hostname and Interface IP address
- Configure Connectivity Passwords
- Configure Privilege Mode / Enable Password
- Verify configuration in RAM and NVRAM
- Saving configuration to the router
- Access the router via Telnet

Establish console connectivity

Establish console connectivity by connecting Router console port to PC Com Port with console cable as shown in the picture below:



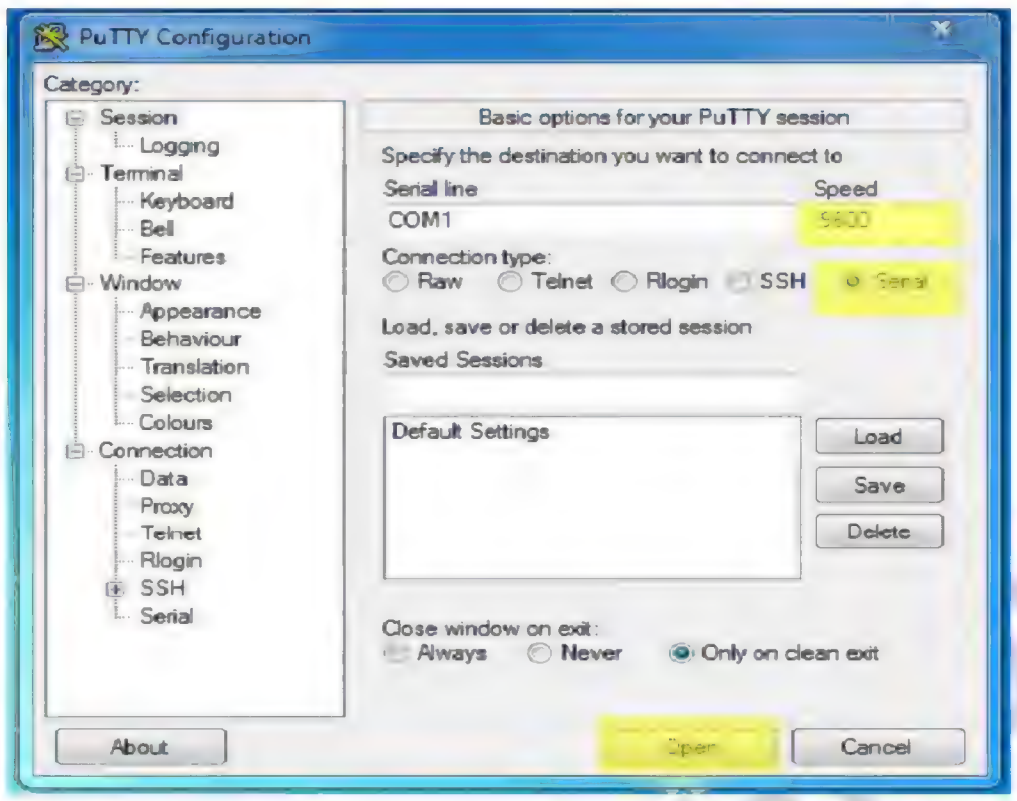
Access router via console with an emulation software

Configure the following parameters in emulation software for accessing router via console port.

Parameters	Console Port Settings
Baud	9600
Data bits	8
Parity	None
Stop bits	1

Accessing router via console from Microsoft Windows Computer

- Start a terminal emulator application, such as **PUTTY.exe**
- Select **Serial** option and set speed to **9600.**
- Click **Open**

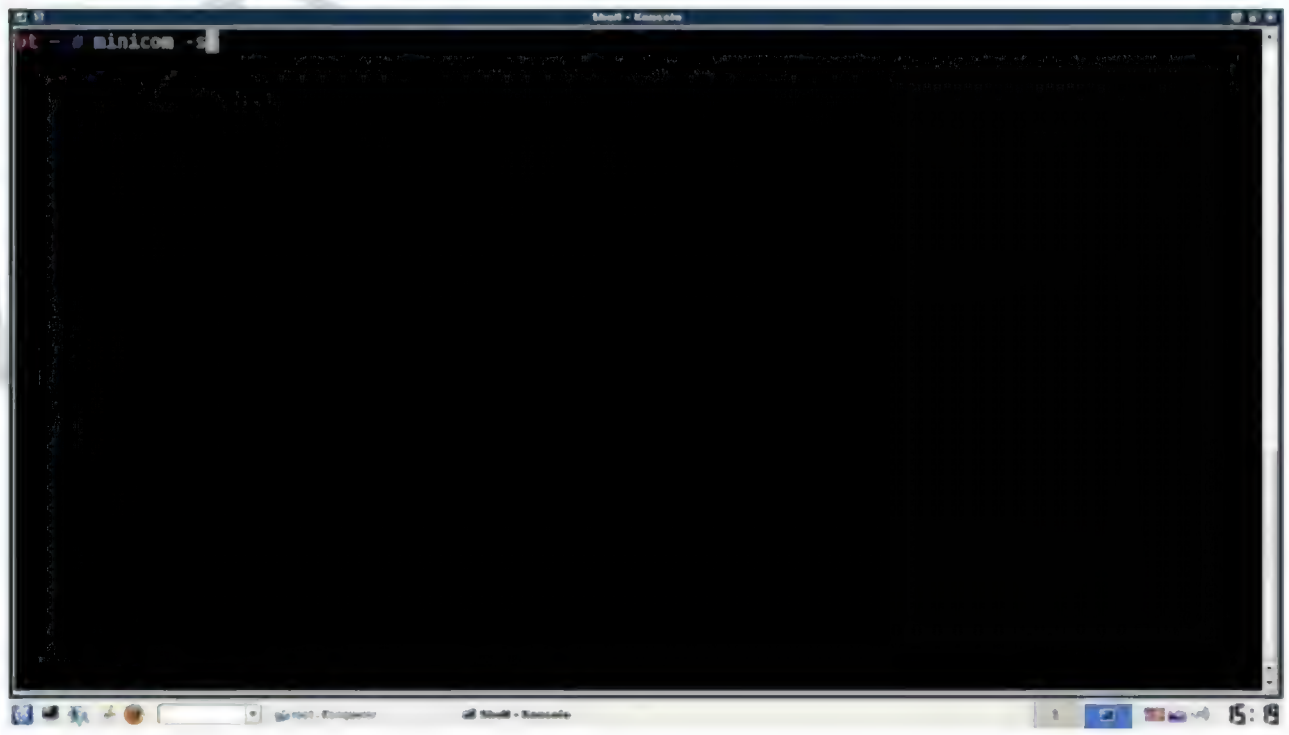


- Once emulation software is ready, **Power-ON** the Router.

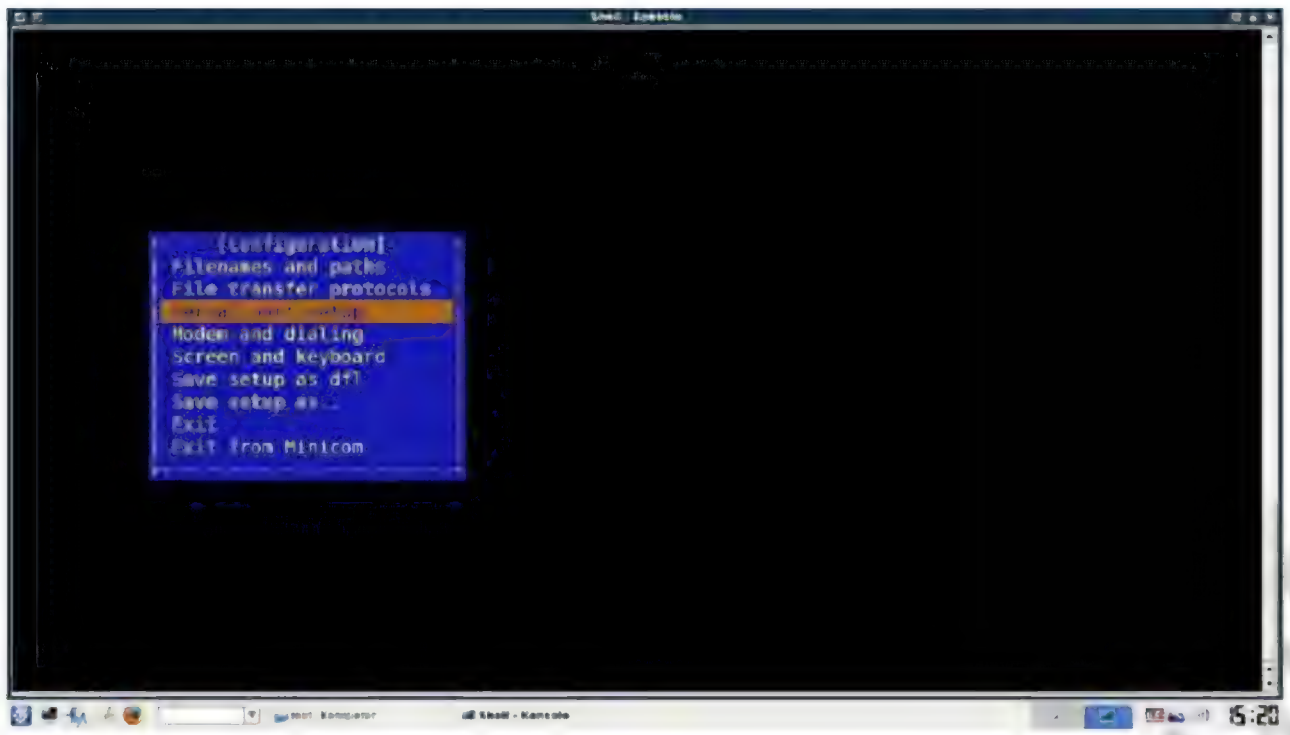
Accessing router via console from Linux Computer

- From the terminal enter the below command

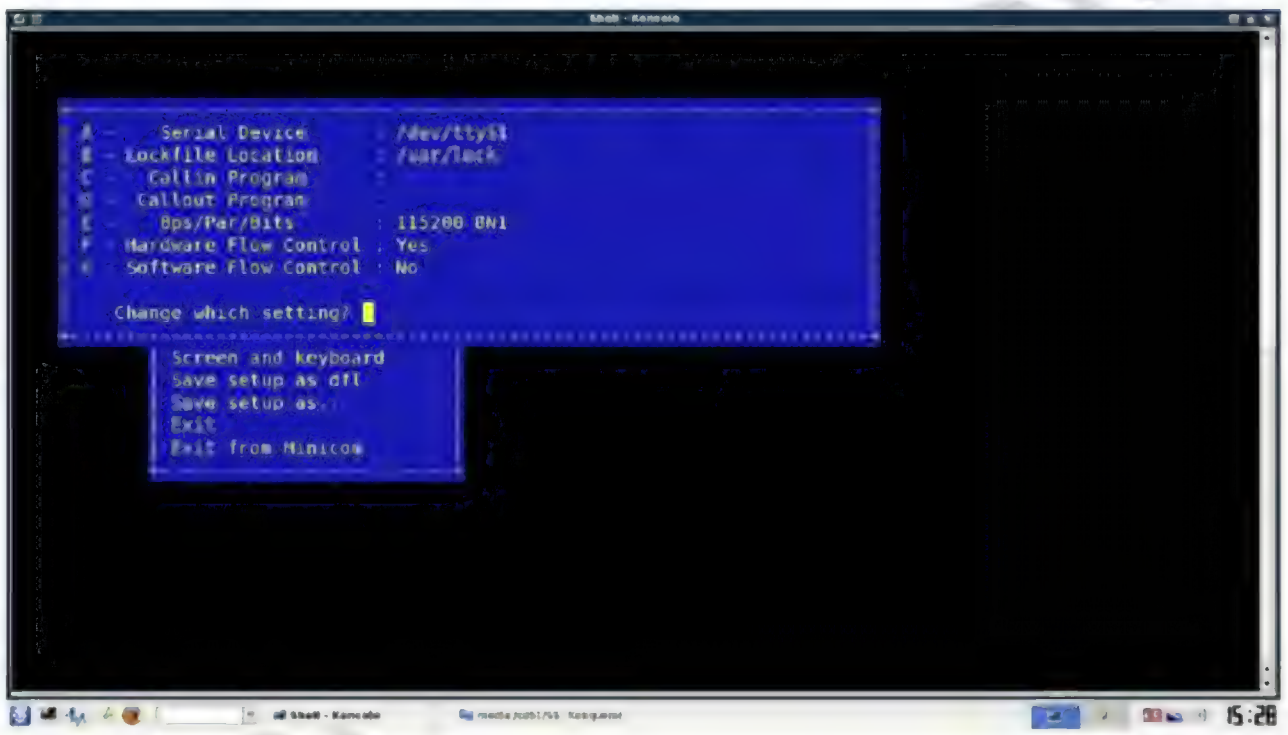
  # minicom –s



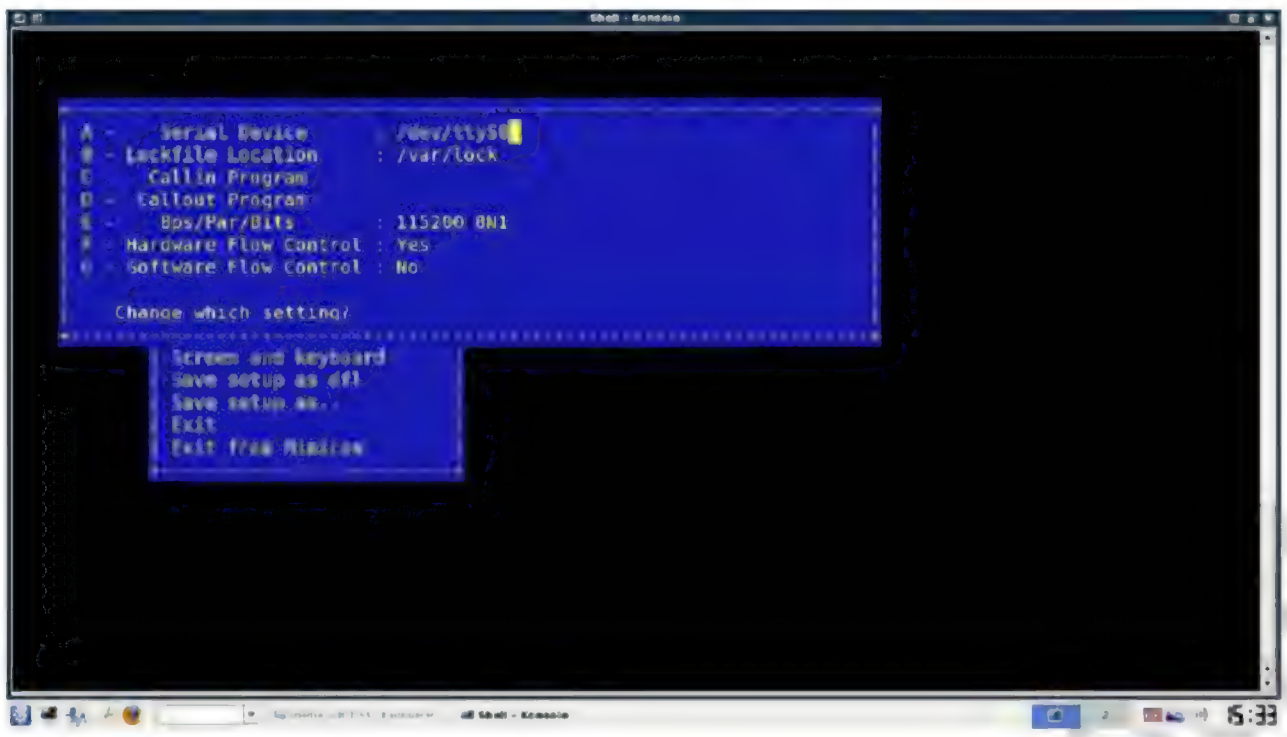
- Select Serial port Setup and press enter



- It will display default **COM Port Settings.**

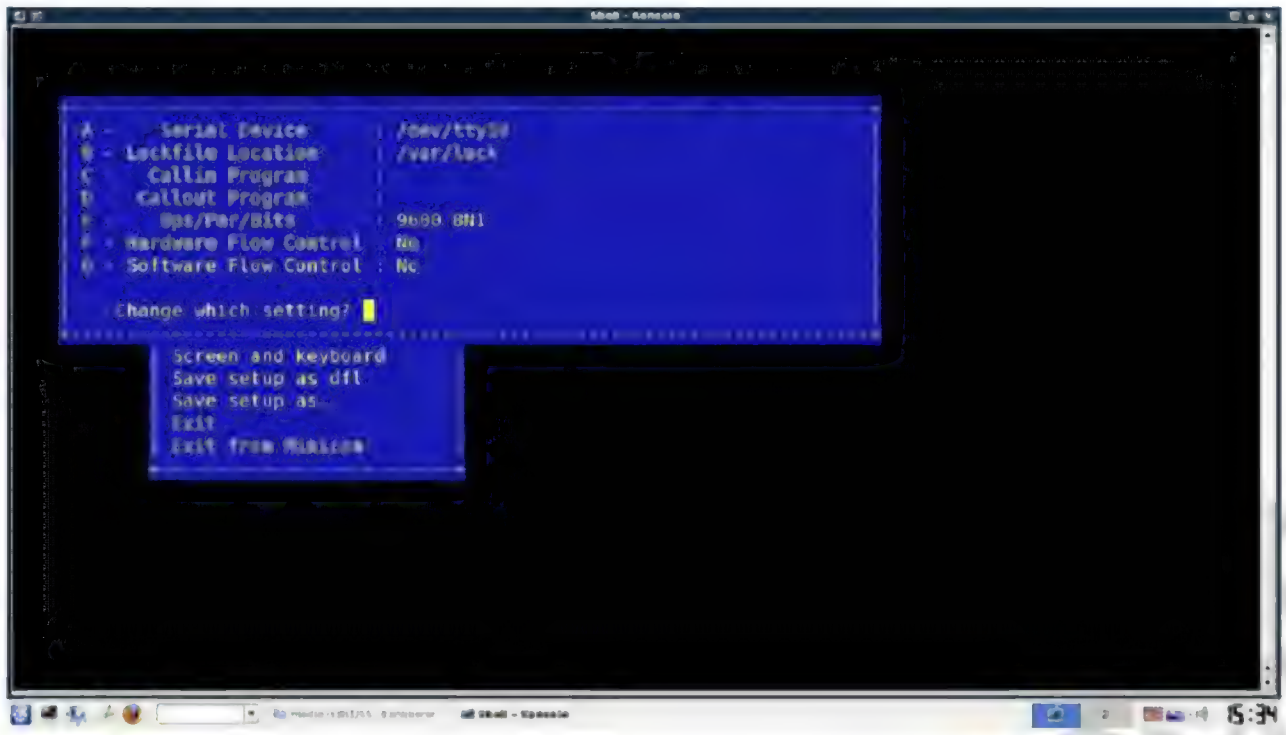


- Specify **COM Port** where console cable is connected.

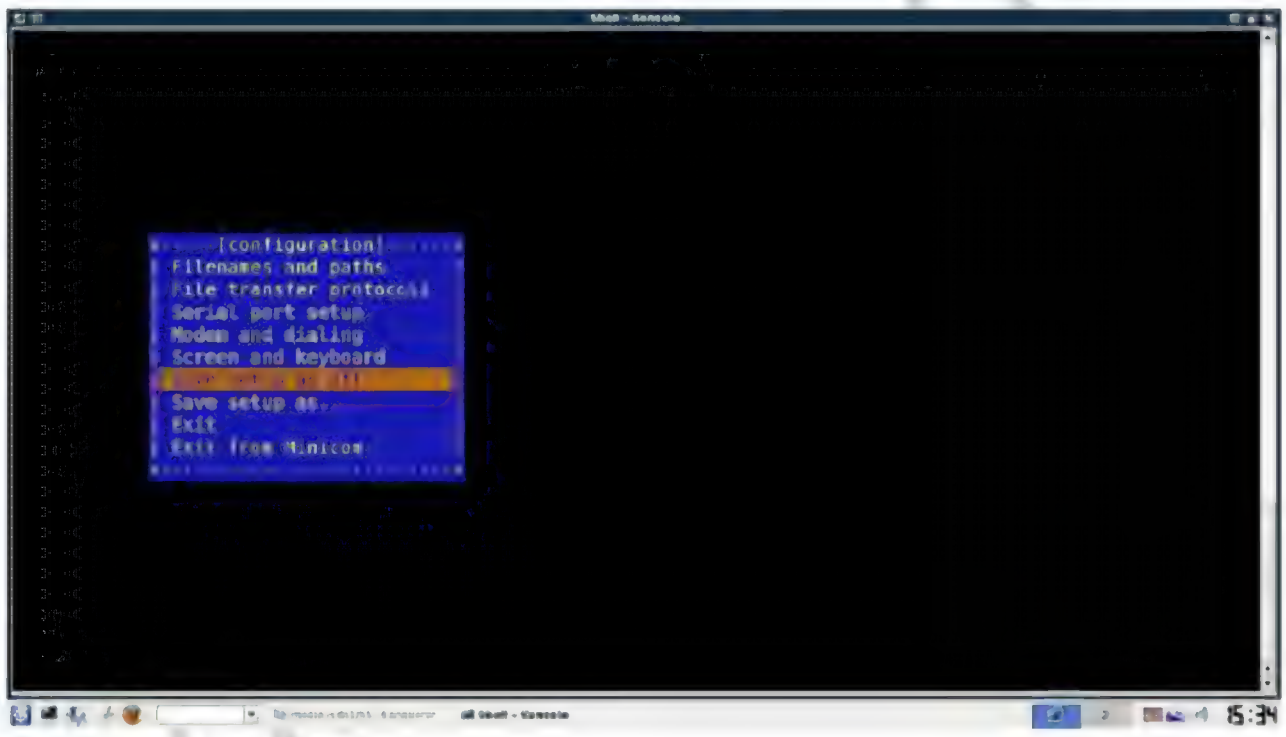


- Change the **Bps Setting** to **9600.**

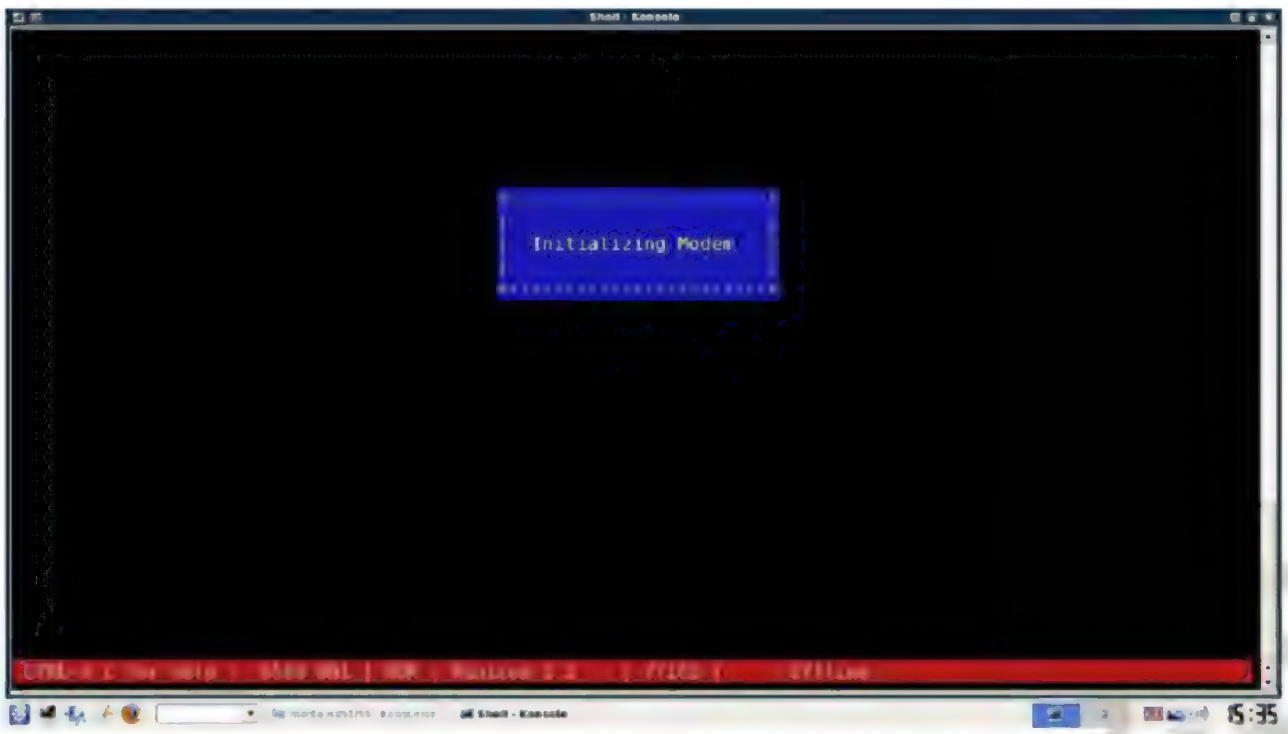
- Change the **Hardware Flow Control** option to **No.**



- Select **Save Setup as dfl** option.



- Exit the **Minicom**



- Once emulation software is ready, **Power-ON** the Router.

Get to know Cisco IOS Modes and Show commands

After the Router boots-up completely, (on a new Cisco Router) it enters setup mode as below:

System Configuration Dialog
Would you like to enter the initial configuration dialog? [Yes/no]: **no**
Would you like to terminate autoinstall? [yes]: **yes**

If you choose "Yes", IOS will prompt questions to gather the information to configure the Router, it is recommended to choose "no", since we can configure the Router using IOS commands

Router >

To navigate into Privilege mode/Executive Mode from User Mode and Vice-Versa

Router>**enable**
Router #

Router# **disable**
Router >

To view router IOS and hardware information

Router # **show version**

Cisco IOS Software, 2800 Software (C2800NM-ADVENTERPRISEK9-M), Version 15.1(3)T2, RELEASE SOFTWARE (fc1)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2011 by Cisco Systems, Inc.
Compiled Wed 10-Aug-11 05:17 by prod_rel_team

ROM: System Bootstrap, Version 12.3(8r)T7, RELEASE SOFTWARE (fc1)

Router uptime is 49 minutes
System returned to ROM by power-on
System image file is "flash:c2800nm-adventerprisek9-mz.151-3.T2.bin"
Last reload type: Normal Reload

This product contains cryptographic features and is subject to United States and local country laws governing import, export, transfer and use. Delivery of Cisco cryptographic products does not imply third-party authority to import, export, distribute or use encryption. Importers, exporters, distributors and users are responsible for compliance with U.S. and local country laws. By using this product you agree to comply with applicable laws and regulations. If you are unable to comply with U.S. and local laws, return this product immediately.

A summary of U.S. laws governing Cisco cryptographic products may be found at:
http://www.cisco.com/wwl/export/crypto/tool/stqrg.html

If you require further assistance please contact us by sending email to export@cisco.com.

Cisco 2821 (revision 53.51) with 249856K/12288K bytes of memory.
Processor board ID FTX0939A2PM
2 Gigabit Ethernet interfaces
2 Serial(sync/async) interfaces
1 Virtual Private Network (VPN) Module
DRAM configuration is 64 bits wide with parity enabled.
239K bytes of non-volatile configuration memory.
125184K bytes of ATA CompactFlash (Read/Write)

License Info:

License UDI:

Device#	PID	SN
*0	CISCO2821	FTX0939A2PM

Configuration register is 0x2102

To view router flash Information

Router # **show flash**
-#- --length-- -----date/time------ path
1 66537232 May 2 2014 08:40:18 +00:00 c2800nm-adventerprisek9-mz.151-3.T2.bin

61376512 bytes available (66541568 bytes used)

To view router current configuration (RAM)

Router # **show running-config**
Building configuration...

Current configuration : 1000 bytes
!
version 15.1
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname Router
!
boot-start-marker
boot-end-marker
!
no aaa new-model
!
dot11 syslog
ip source-route
!
ip cef
!
no ipv6 cef
!
multilink bundle-name authenticated
!
voice-card 0
!
crypto pki token default removal timeout 0
!
license udi pid CISCO2821 sn FTX0939A2PM
!
redundancy
!
interface GigabitEthernet0/0
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface GigabitEthernet0/1

```
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 shutdown
 clock rate 2000000
!
interface Serial0/0/1
 no ip address
 shutdown
!
ip forward-protocol nd
no ip http server
no ip http secure-server
!
logging esm config
!
control-plane
!
mgcp profile default
!
line con 0
line aux 0
line vty 0 4
 login
 transport input all
!
scheduler allocate 20000 1000
end
```

To view router startup configuration (NVRAM)

Router# **show startup-config**

startup-config is not present

To navigate into Global Configuration Mode

Router # **configure terminal**
Router (config) #

Configure Hostname and Interface IP address

To change the Host Name of Router

Router (config) # **hostname R1**
R1 (config) #

To configure IP address on Ethernet Interface (LAN interface)

R1 (config) # **interface Gigabitethernet 0/0**
R1 (config-if) # **ip address 10.0.0.1 255.0.0.0**
R1 (config-if) # **no shutdown**
R1 (config-if) #**exit**

Configure Connectivity Passwords

To configure telnet password

R1 (config) # **line vty 0 4**
R1 (config-line) # **password zoom**
R1 (config-line) #**login**
R1 (config-line) #**exit**

To configure console password

R1 (config) # **line console 0**
R1 (config-line) # **password ccna**
R1 (config-line) #**login**
R1 (config-line) # **exit**

To configure auxiliary password

R1 (config) # **line aux 0**
R1 (config-line) # **password cisco**
R1 (config-line) # **login**
R1 (config-line) # **exit**

Configure Privilege Mode / Enable Password

Configure privilege password

R1 (config) #**enable password ccna**
R1 (config) #**enable secret zoom**

Verify configuration in RAM and NVRAM

To View Router Current Configuration (RAM)

R1# **show running-config**
Building configuration...
Current configuration : 1197 bytes
!
! Last configuration change at 14:07:57 UTC Fri Jul 17 2015
!
version 15.1
service timestamps debug datetime msec

```
service timestamps log datetime msec
no service password-encryption
!
hostname R1
!
boot-start-marker
boot-end-marker
!
enable secret 5 $1$c3y7$lmD5cmfnVAxSyns0r4dMx0
enable password ccna
!
no aaa new-model
!
dot11 syslog
ip source-route
!
ip cef
!
no ipv6 cef
!
multilink bundle-name authenticated
!
voice-card 0
!
crypto pki token default removal timeout 0
!
license udi pid CISCO2821 sn FTX0939A2PM
!
redundancy
!
interface GigabitEthernet0/0
 ip address 10.0.0.1 255.0.0.0
 duplex auto
 speed auto
!
interface GigabitEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 shutdown
 clock rate 2000000
!
interface Serial0/0/1
 no ip address
 shutdown
!
ip forward-protocol nd
```

```
no ip http server
no ip http secure-server
!
logging esm config
!
control-plane
!
mgcp profile default
!
line con 0
 password ccna
 login
line aux 0
 password cisco
 login
line vty 0 4
 password zoom
 login
 transport input all
!
scheduler allocate 20000 1000
end
```

To View Router Startup Configuration (NVRAM)

R1 # **show startup-config**

```
startup-config is not present
```

Saving configuration to the router

To save configuration on router

R1 # **copy running-config startup-config**

```
Destination filename [startup-config]?
Building configuration...

[OK]
R1 #
```

To view router startup configuration (NVRAM)

R1 # **show startup-config**

```
Using 1197 out of 245752 bytes
!
! Last configuration change at 14:07:57 UTC Fri Jul 17 2015
!
version 15.1
service timestamps debug datetime msec
service timestamps log datetime msec
```

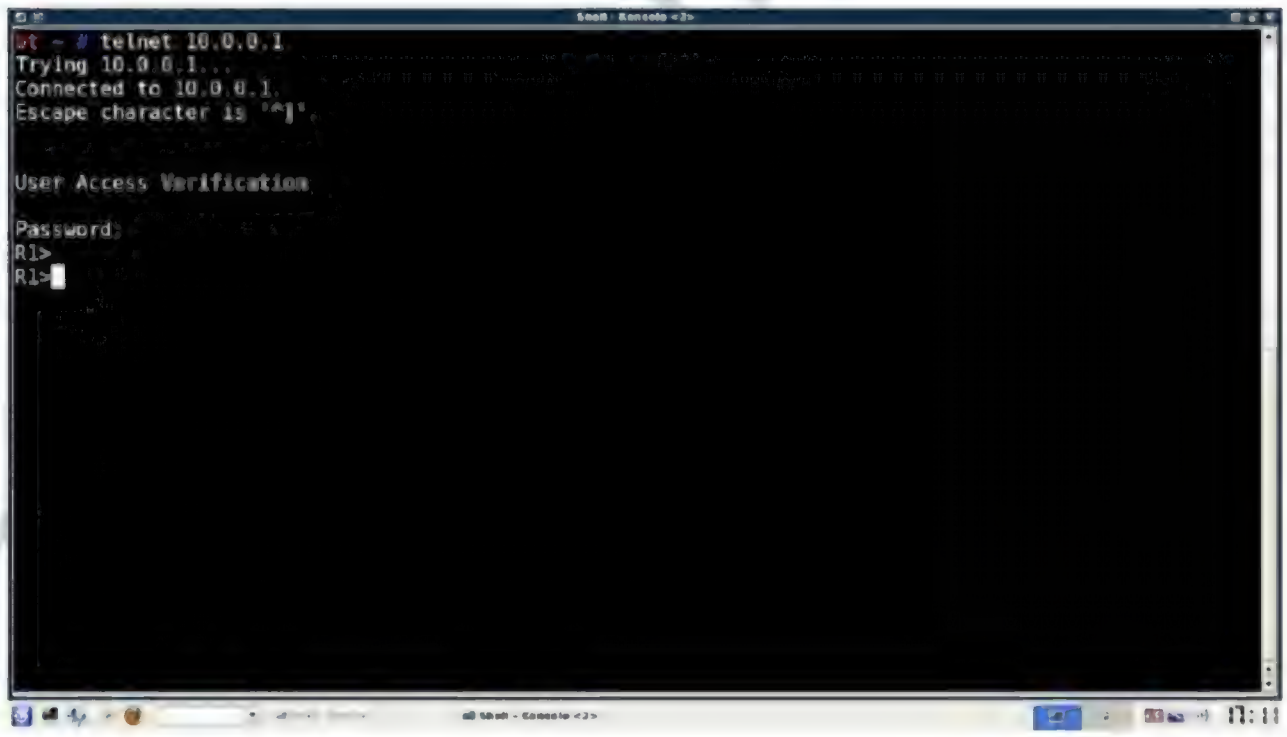
```
no service password-encryption
!
hostname R1
!
boot-start-marker
boot-end-marker
!
enable secret 5 $1$c3y7$lmD5cmfnVAxSyns0r4dMx0
enable password ccna
!
no aaa new-model
!
dot11 syslog
ip source-route
!
!
ip cef
!
!
!
no ipv6 cef
!
multilink bundle-name authenticated
!
crypto pki token default removal timeout 0
!
license udi pid CISCO2821 sn FTX0939A2PM
!
interface GigabitEthernet0/0
 ip address 10.0.0.1 255.0.0.0
 duplex auto
 speed auto
!
interface GigabitEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 shutdown
 clock rate 2000000
!
interface Serial0/0/1
 no ip address
 shutdown
!
ip forward-protocol nd
no ip http server
no ip http secure-server
```

```
!
logging esm config
!
control-plane
!
mgcp profile default
!
line con 0
 password ccna
 login
line aux 0
 password cisco
 login
line vty 0 4
 password zoom
 login
 transport input all
!
scheduler allocate 20000 1000
end
```

Access the router via Telnet

- Accessing router via telnet by giving below command on a Windows or Linux computer.

  telnet 10.0.0.1



LAB 2: ENHANCING ROUTER SECURITY

OBJECTIVE:

To enhance router security by encrypting all passwords , configure banners, exec-timeouts, username and password security and enabling SSH access on router.

TOPOLOGY:

Setup Ethernet connectivity for the lab as below :

Pre-requisite: Initial configuration to be done on the router (LAB – 1)

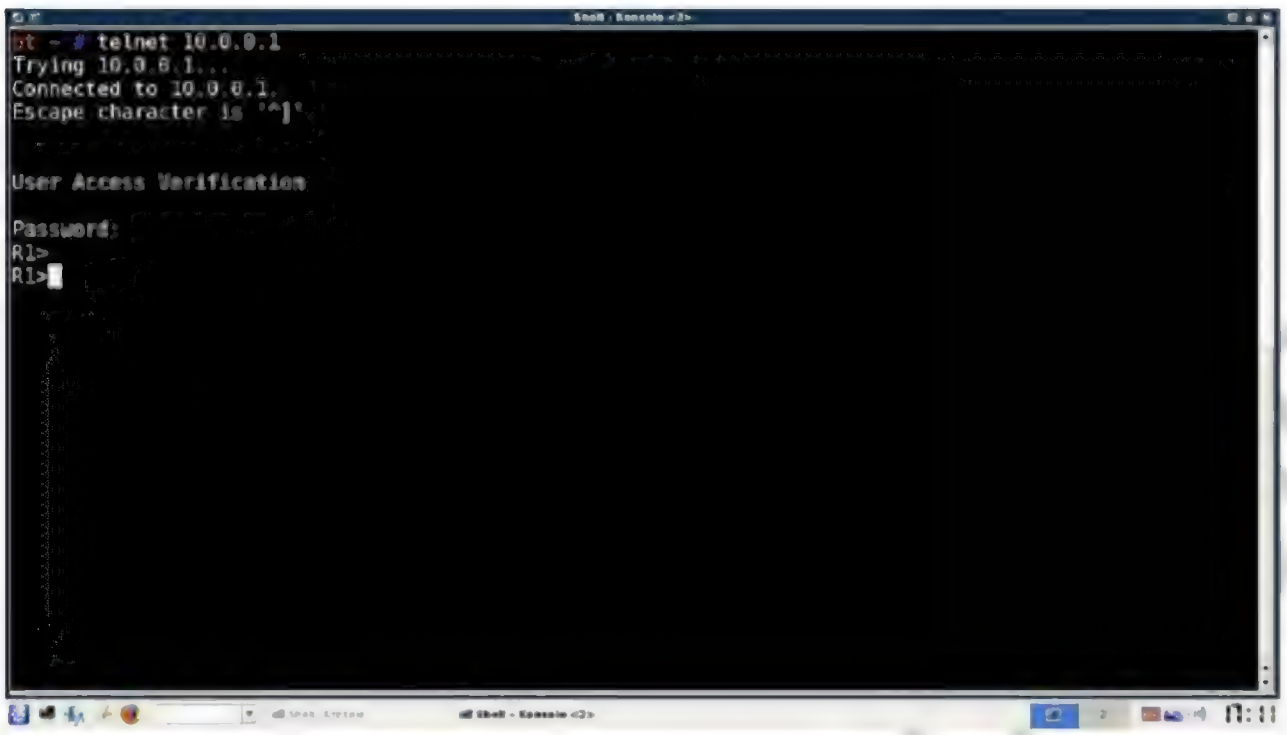
TASKS:

- Access router via Telnet
- Encrypt all clear text passwords on the router.
- Configure Warning Banner and Idle-timeout on Router
- Configure unattended session timeout for VTY access
- Configure Enhanced Username Password Security on Routers
- Configure the SSH Server on Router

Access router via Telnet

- Access router via telnet by giving below command on a Windows or Linux computer.

  telnet 10.0.0.1



Encrypt all clear text passwords on the router

Verify router's existing configuration

All password are in clear text except **enable secret password**

R1 # **sh running-config**

```
Building configuration...
Current configuration : 1221 bytes
!
! Last configuration change at 18:22:59 UTC Mon Jul 20 2015 by zoom
!
version 15.1
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R1
!
boot-start-marker
boot-end-marker
!
enable secret 5 $1$Eo2F$oKXKSAmJK5Tyq3uYmP8ln.
enable password ccna
!
no aaa new-model
!
dot11 syslog
```

```
ip source-route
!
interface GigabitEthernet0/0
 ip address 10.0.0.1 255.0.0.0
 duplex auto
 speed auto
!
interface GigabitEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 shutdown
!
interface Serial0/0/1
 no ip address
 shutdown
!
ip forward-protocol nd
no ip http server
no ip http secure-server
!
logging esm config
!
control-plane
!
mgcp profile default
!
line con 0
password ccna
 login
line aux 0
password cisco
 login
line vty 0 4
 exec-timeout 0 0
password zoom
 login
 transport input all
!
scheduler allocate 20000 1000
end

R1#
```

Encrypt all clear text passwords

R1 (config) # **service password-encryption**

Verification:

Now previously visible passwords are encrypted

R1 # **sh running-config**

```
Building configuration...
Current configuration : 1221 bytes
!
! Last configuration change at 18:22:59 UTC Mon Jul 20 2015 by zoom
!
version 15.1
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R1
!
boot-start-marker
boot-end-marker
!
enable secret 5 $1$Eo2F$oKXKSAmJK5Tyq3uYmP8ln.
enable password 7 0508050120
!
no aaa new-model
!
dot11 syslog
ip source-route
!
interface GigabitEthernet0/0
 ip address 10.0.0.1 255.0.0.0
 duplex auto
 speed auto
!
interface GigabitEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 shutdown
!
interface Serial0/0/1
 no ip address
 shutdown
!
```

```
ip forward-protocol nd
no ip http server
no ip http secure-server
!
logging esm config
!
control-plane
!
mgcp profile default
!
line con 0
password 7 08224F4008
 login
line aux 0
 password 7 1511021F0725
 login
line vty 0 4
 exec-timeout 0 0
 password 7 12030A181F
 login
 transport input all
!
scheduler allocate 20000 1000
end

R1#
```

Configure Warning Banner and Idle-timeout on Routers

Configure a warning message to display prior to login.

R1 (config) # **banner motd $**

Enter TEXT message. End with the character '$'.

==========

UNAUTHORISED ACCESS STRICTLY PROHIBITED AND PROSECUTED

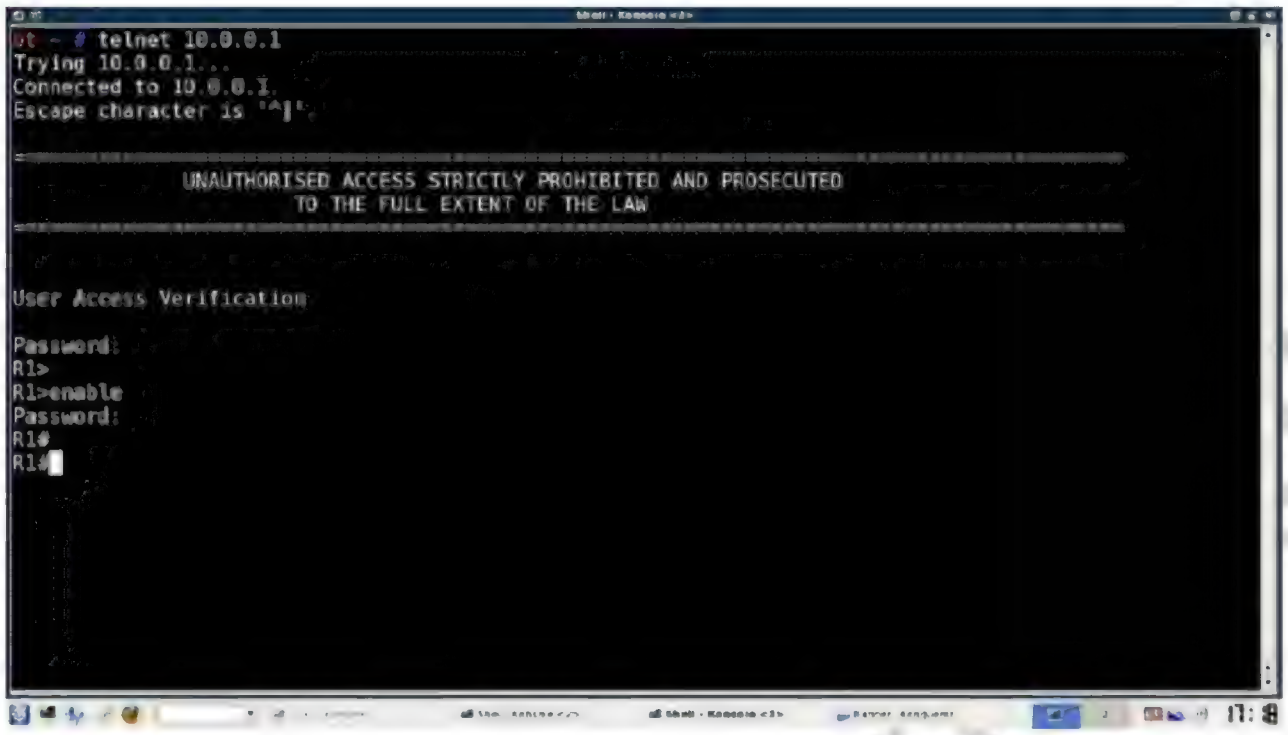
TO THE FULL EXTENT OF THE LAW

==========$

Verification:

Now open a new telnet session from your computer to the router to verify the banner configured.

i.e. **telnet 10.0.0.1**



Configure unattended session timeout for VTY access

By default unattended session time-out is 10 minutes. We reducing the unattended session timeout to 1 minute 00 seconds.

R1 (config) # **line vty 0 4**

R1 (config-line) # **exec-timeout 1 00**

Verification:

Now open a new telnet session from your computer to the router (get into privilege mode) and leave the session open without performing any action or modification for 1 minute. Session will be automatically disconnected after the session time-out has been reached.

```
bt ~ #
bt ~ #
bt ~ # ssh -l zoom 10.0.0.1
The authenticity of host '10.0.0.1 (10.0.0.1)' can't be established.
RSA key fingerprint is 1d:3b:15:64:86:56:7c:2b:cd:b3:1c:84:47:4e:f0:72.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added '10.0.0.1' (RSA) to the list of known hosts.
Password:

=============================================================================
                UNAUTHORISED ACCESS STRICTLY PROHIBITED AND PROSECUTED
                        TO THE FULL EXTENT OF THE LAW
=============================================================================

R1>
R1>Connection to 10.0.0.1 closed by remote host.
Connection to 10.0.0.1 closed.
bt ~ #
bt ~ #
bt ~ #
bt ~ #
bt ~ #
bt ~ #
bt ~ #
bt ~ #
bt ~ #
bt ~ #
bt ~ #
bt ~ #
```

Configure Enhanced Username Password Security on Routers

Configure a new user with password

R1(config)# **username zoom password cisco**

Enabling userwise access for VTY session

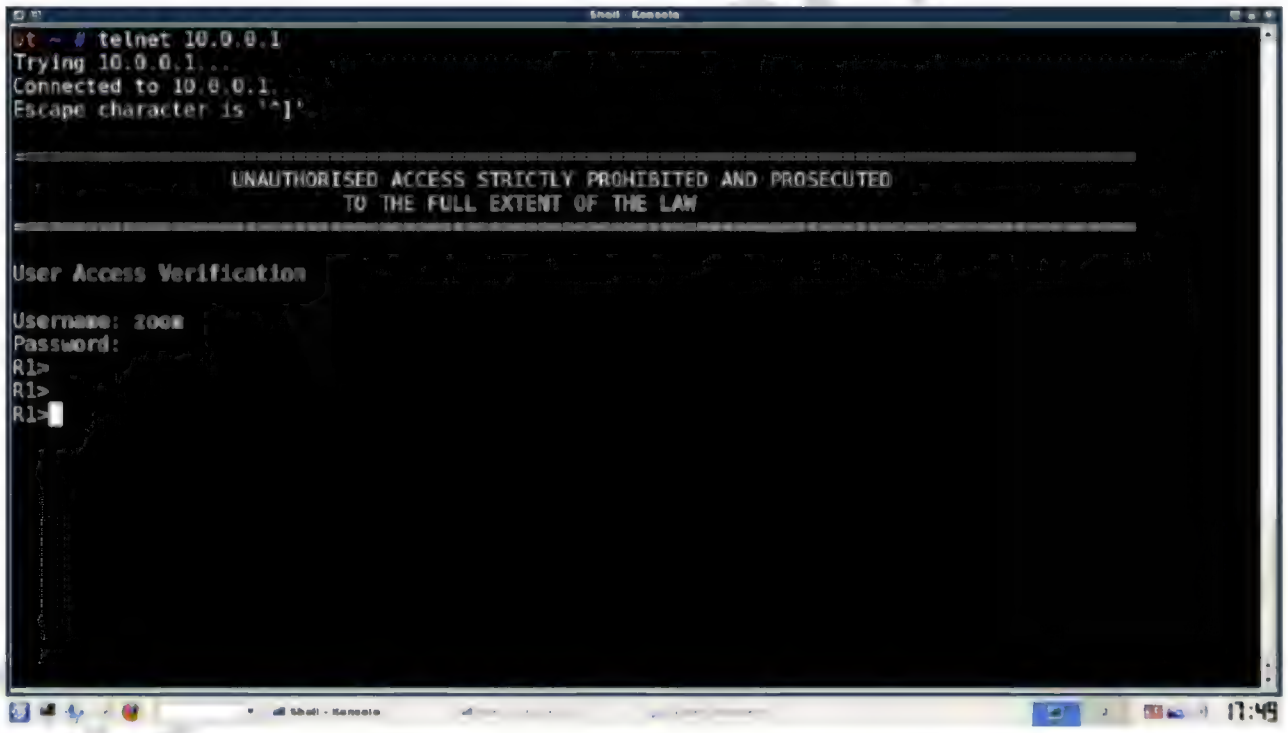
R1(config)# **line vty 0 4**

R1(config-line)# **login local**

Verification:

Now open a new telnet session from your computer to the router and try to login using already configured user.

i.e. **telnet 10.0.0.1**



Configure the SSH Server on Router

Configure a domain name

R1 (config) # **ip domain-name zoom.com**

Configure the vty lines.

R1 (config) # **line vty 0 4**

R1 (config-line) # **login local**

R1 (config-line) # **transport input ssh**

R1 (config-line) # **exit**

Generate the RSA encryption key pair for the router

R1(config)# **crypto key generate rsa**

The name for the keys will be: R1.zoom.com
Choose the size of the key modulus in the range of 360 to 2048 for your
General Purpose Keys. Choosing a key modulus greater than 512 may take a few minutes.

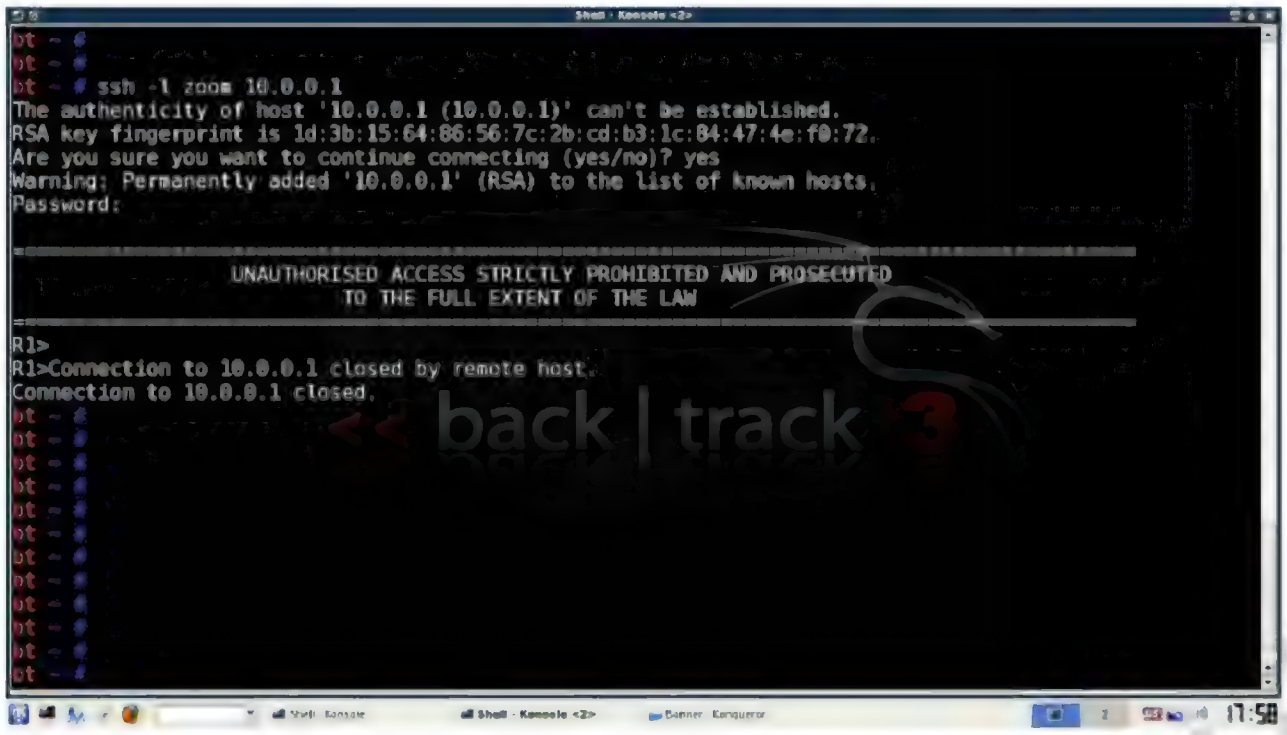
How many bits in the modulus [512]: **1024**
% Generating 1024 bit RSA keys, keys will be non-exportable...
[OK] (elapsed time was 3 seconds)
R1(config)#

Verification:

Now open a new telnet session from your computer to the router, you will not able to access router via telnet.

Verify SSH access to R1 from computer by giving below command :

ssh -l zoom 10.0.0.1



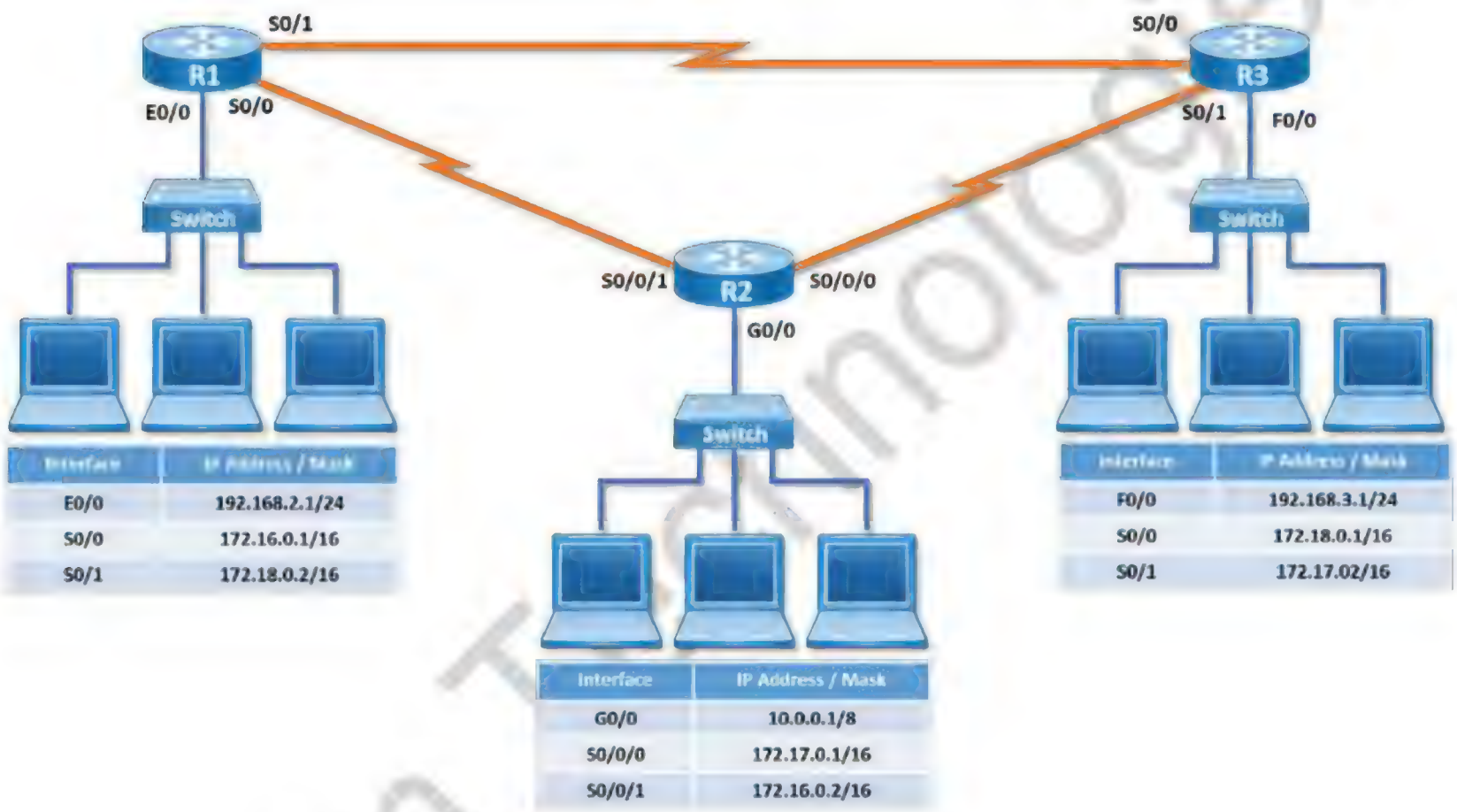
LAB 3: WAN INTERFACE CONFIGURATION

OBJECTIVE:

To configure and troubleshoot a Serial Interface.

TOPOLOGY:

Setup Ethernet and Serial connectivity for the lab as below :



Interface	IP Address / Mask
E0/0	192.168.2.1/24
S0/0	172.16.0.1/16
S0/1	172.18.0.2/16

Interface	IP Address / Mask
F0/0	192.168.3.1/24
S0/0	172.18.0.1/16
S0/1	172.17.02/16

Interface	IP Address / Mask
G0/0	10.0.0.1/8
S0/0/0	172.17.0.1/16
S0/0/1	172.16.0.2/16

TASK:

- Identify Serial Interface as DCE or DTE
- Configure Serial Interface
- Verify Serial Interface Configuration
- Troubleshooting Serial Interface

Identify Serial Interface as DCE or DTE

Example - R2

Identify DCE / DTE interface on R2

R2 **# show controllers serial 0/0/0**
Interface Serial0/0/0
Hardware is GT96K
DCE V.35, clock rate 2000000
idb at 0x497698FC, driver data structure at 0x49770EAC
wic_info 0x497714D8
Physical Port 1, SCC Num 1
!
<output omitted>
!

R2 # **show controllers serial 0/0/1**
Interface Serial0/0/1
Hardware is GT96K
DTE V.35idb at 0x497739F0, driver data structure at 0x4977B1E4
wic_info 0x4977B810
Physical Port 0, SCC Num 0
!
<output omitted>
!

Verify Serial Interface existing status

R2 # **show interface serial 0/0/0**
Serial0/0/0 is administratively down, line protocol is down
  Hardware is GT96K Serial
  MTU 1500 bytes, BW 1544 Kbit/sec, DLY 20000 usec,
    reliability 255/255, txload 1/255, rxload 1/255
Encapsulation HDLC, loopback not set
  Keepalive set (10 sec)
  !
<output omitted>
  !

R2 # **show interface serial 0/0/1**
Serial0/0/1 is administratively down, line protocol is down
  Hardware is GT96K Serial
  MTU 1500 bytes, BW 1544 Kbit/sec, DLY 20000 usec,
    reliability 255/255, txload 1/255, rxload 1/255
Encapsulation HDLC, loopback not set
  Keepalive set (10 sec)
  !
<output omitted>
  !

Verify R2's existing configuration

```
R2 # show running-config
Building configuration...
Current configuration : 1210 bytes
hostname R2
!
<output omitted>
!
interface GigabitEthernet0/0
 ip address 10.0.0.1 255.0.0.0
 duplex auto
 speed auto
!
interface GigabitEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
no ip address
 shutdown
!
interface Serial0/0/1
 no ip address
 shutdown
!
<output omitted>
!
end

R2 #
```

Repeat the above commands on R1 and R3 routers.

Configure Serial Interface

R1 – Configuration

```
R1 # configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
R1 (config)# interface serial 0/0
R1 (config-if)# ip address 172.16.0.1 255.255.0.0
R1 (config-if)# no shutdown
R1 (config-if)# clock rate 64000
R1 (config-if)# encapsulation hdlc
R1 (config-if)# exit
R1 (config)#
```

R1 (config)# **interface serial 0/1**
R1 (config-if)# **ip address 172.18.0.2 255.255.0.0**
R1 (config-if)# **no shutdown**
R1 (config-if)# **encapsulation hdlc**
R1 (config-if)# **exit**
R1 (config)# **exit**

R2 – Configuration

R2 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R2 (config)# **interface serial 0/0/0**
R2 (config-if)# **ip address 172.17.0.1 255.255.0.0**
R2 (config-if)# **no shutdown**
R2 (config-if)# **clock rate 64000**
R2 (config-if)# **encapsulation hdlc**
R2 (config-if)# **exit**
R2 (config)#

R2 (config)# **interface serial 0/0/1**
R2 (config-if)# **ip address 172.16.0.2 255.255.0.0**
R2 (config-if)# **no shutdown**
R2 (config-if)# **encapsulation hdlc**
R2 (config-if)# **exit**
R2 (config)# **exit**

R3 – Configuration

R3 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R3 (config)# **interface serial 0/0**
R3 (config-if)# **ip address 172.18.0.1 255.255.0.0**
R3 (config-if)# **no shutdown**
R3 (config-if)# **clock rate 64000**
R3 (config-if)# **encapsulation hdlc**
R3 (config-if)# **exit**
R3 (config)#

R3 (config)# **interface serial 0/1**
R3 (config-if)# **ip address 172.17.0.2 255.255.0.0**
R3 (config-if)# **no shutdown**
R3 (config-if)# **encapsulation hdlc**
R3 (config-if)# **exit**
R3 (config)# **exit**

Verify Serial Interface Configuration

R1 – Verification

R1 # **show interface serial 0/0**
Serial0/0 is up, line protocol is up
  Hardware is PowerQUICC Serial
Internet address is 172.16.0.1/16
  MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
Encapsulation HDLC, loopback not set
  Keepalive set (10 sec)
  !
<output omitted>
  !

R1# **show interface serial 0/1**
Serial0/1 is up, line protocol is up
  Hardware is PowerQUICC Serial
Internet address is 172.18.0.2/16
  MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
Encapsulation HDLC, loopback not set
  Keepalive set (10 sec)
  !
<output omitted>
  !

R2 – Verification:

R2 # **show interface serial 0/0/0**
Serial0/0/0 is up, line protocol is up
  Hardware is GT96K Serial
Internet address is 172.17.0.1/16
  MTU 1500 bytes, BW 1544 Kbit/sec, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
Encapsulation HDLC, loopback not set
  Keepalive set (10 sec)
  !
<output omitted>
  !

R2 # **show interface serial 0/0/1**
Serial0/0/1 is up, line protocol is up
  Hardware is GT96K Serial
Internet address is 172.16.0.2/16
  MTU 1500 bytes, BW 1544 Kbit/sec, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
Encapsulation HDLC, loopback not set
  Keepalive set (10 sec)
  !

<output omitted>

R3 – Verification:

```
R3 # show interface  serial 0/0
Serial0/0 is up, line protocol is up
  Hardware is PowerQUICC Serial
Internet address is 172.18.0.1/16
  MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
Encapsulation HDLC, loopback not set
  Keepalive set (10 sec)
   !
<output omitted>
  !

R3 # show interface  serial 0/1
Serial0/1 is up, line protocol is up
  Hardware is PowerQUICC Serial
Internet address is 172.17.0.2/16
  MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
Encapsulation HDLC, loopback not set
  Keepalive set (10 sec)
  !
<output omitted>
  !
```

Troubleshooting Serial Interface

From the output, the first line indicates the status of the Serial interface. There are 4 possible states:

1. **Serial 0/0 is up , line protocol is up**

   Layer 1 and Layer 2 Connectivity and configuration is fine

2. **Serial 0/0 is administratively down, line protocol is down**

   'No Shutdown' has to be given on the local Router's Serial interface

3. **Serial 0/0 is up, line protocol is down**

   Encapsulation mismatch or clock rate has not been given on the DCE interface or Lease Line problem

4. **Serial 0/0 is down, line protocol is down**

   Problem with the v.35 cable, CSU/DSU or 'no shutdown' has not been given on the remote Router

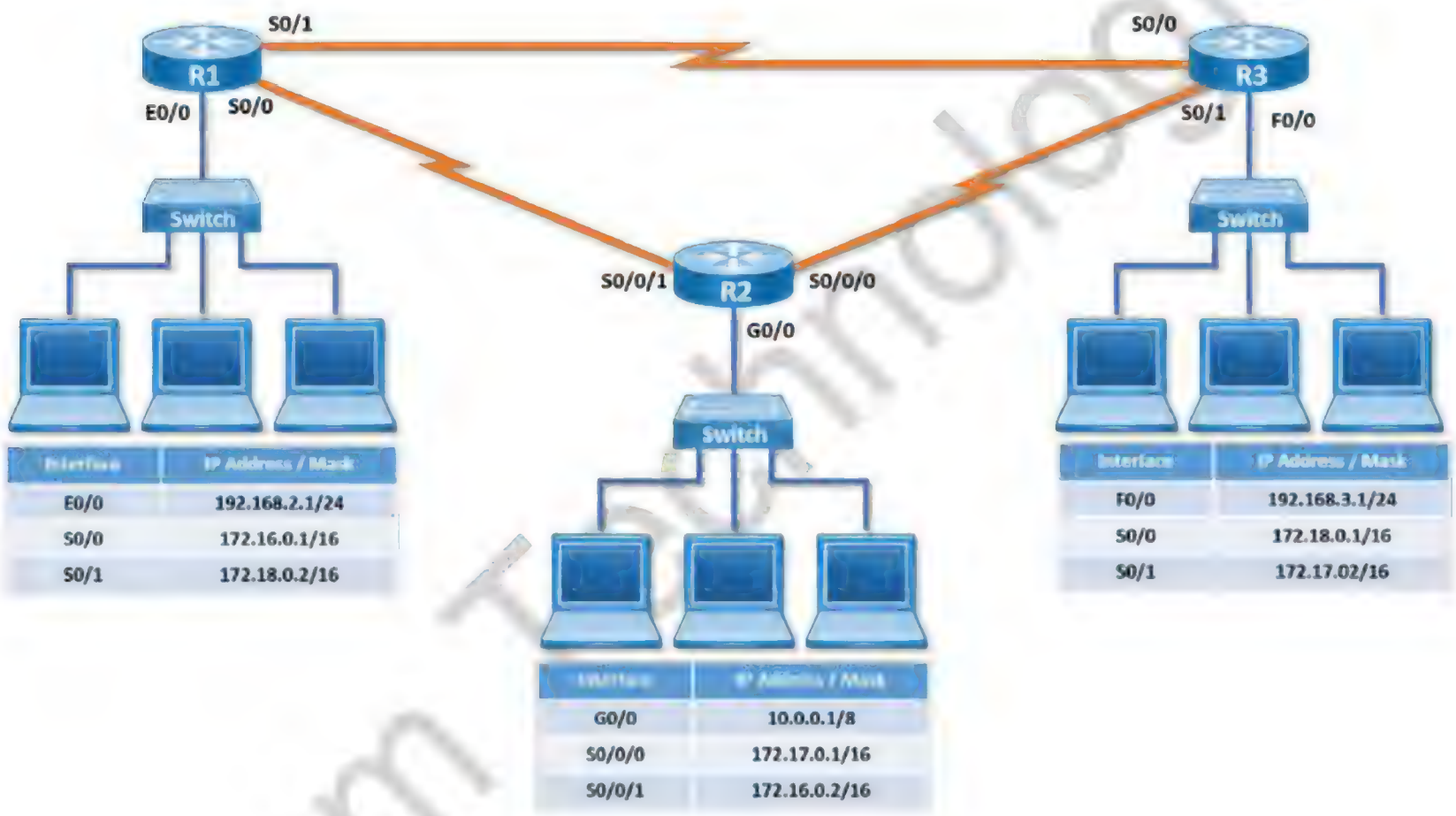
LAB 4: STATIC ROUTING

OBJECTIVE:

To configure Static Routing for enabling communication between different networks connected to different routers. To set up static routes on R1, R2, R3 to connect to each other's local networks.

TOPOLOGY:

Setup Ethernet and Serial connectivity for the lab as below :



Pre-requisite: WAN Interface configuration to be done on the router (LAB – 3)

TASK:

- Enabling IPv4 Routing
- Verify Routing Table
- Configure Static Routing
- Verify Static Routing
- Verify communication between the networks.

Enabling IPv4 Routing

R1 – Configuration

R1 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R1 (config) # **ip routing**
R1 (config) #

R2 – Configuration

R2 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R2 (config) # **ip routing**
R2 (config) #

R3 – Configuration

R3 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R3 (config) # **ip routing**
R3 (config) #

Note : Once routing is enabled the directly connected networks are automatically added into the routing information table. **"C"**represents directly connected networks. The IP Network is learnt through the local Interface of the router.

Verify Routing Table

R1 – Verification:

R1 # **show ip route**
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
* - candidate default, U - per-user static route, o - ODR
P - periodic downloaded static route

Gateway of last resort is not set

C 172.16.0.0/16 is directly connected, Serial0/0
C 172.18.0.0/16 is directly connected, Serial0/1
C 192.168.2.0/24 is directly connected, Ethernet0/0
R1 #

R2 – Verification:

R2 # **show ip route**
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2
i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
ia - IS-IS inter area, * - candidate default, U - per-user static route
o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
+ - replicated route, % - next hop override

Gateway of last resort is not set

10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C 10.0.0.0/8 is directly connected, GigabitEthernet0/0
L 10.0.0.1/32 is directly connected, GigabitEthernet0/0
172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C 172.16.0.0/16 is directly connected, Serial0/0/1
L 172.16.0.2/32 is directly connected, Serial0/0/1
172.17.0.0/16 is variably subnetted, 2 subnets, 2 masks
C 172.17.0.0/16 is directly connected, Serial0/0/0
L 172.17.0.1/32 is directly connected, Serial0/0/0
R2 #

R3 – Verification:

R3 # **show ip route**
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2
i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
ia - IS-IS inter area, * - candidate default, U - per-user static route
o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

C 172.17.0.0/16 is directly connected, Serial0/1
C 172.18.0.0/16 is directly connected, Serial0/0
C 192.168.3.0/24 is directly connected, FastEthernet0/0
R3 #

Configure Static Routing

R1 – Configuration

R1 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R1 (config) # **ip route 10.0.0.0 255.0.0.0 172.16.0.2**
R1 (config) # **ip route 192.168.3.0 255.255.255.0 172.18.0.1**
R1 (config) # **exit**
R1 (config) #

R2 – Configuration

R2 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R2 (config) # **ip route 192.168.2.0 255.255.255.0 172.16.0.1**
R2 (config) # **ip route 192.168.3.0 255.255.255.0 172.17.0.2**
R2 (config) # **exit**
R2 (config) #

R3 – Configuration

R3 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R3 (config) # **ip route 10.0.0.0 255.0.0.0 172.17.0.1**
R3 (config) # **ip route 192.168.3.0 255.255.255.0 172.18.0.2**
R3 (config) # **exit**
R3 (config) #

Verify Static Routing

Once Static routing is enabled, the IP Networks defined with the **Static routing command** are added into the routing information table. **"S"** represents **Static route.**

R1 – Verification:

R1 # **show ip route**

Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
* - candidate default, U - per-user static route, o - ODR
P - periodic downloaded static route

Gateway of last resort is not set

C 172.16.0.0/16 is directly connected, Serial0/0
C 172.18.0.0/16 is directly connected, Serial0/1
S 10.0.0.0/8 [1/0] via 172.16.0.2

C 192.168.2.0/24 is directly connected, Ethernet0/0
S 192.168.3.0/24 [1/0] via 172.18.0.1
R1 #

R2 – Verification:

R2 # **show ip route**
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2
i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
ia - IS-IS inter area, * - candidate default, U - per-user static route
o - ODR, P - periodic downloaded static route
+ - replicated route, % - next hop override

Gateway of last resort is not set

10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C 10.0.0.0/8 is directly connected, GigabitEthernet0/0
L 10.0.0.1/32 is directly connected, GigabitEthernet0/0
172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C 172.16.0.0/16 is directly connected, Serial0/0/1
L 172.16.0.2/32 is directly connected, Serial0/0/1
172.17.0.0/16 is variably subnetted, 2 subnets, 2 masks
C 172.17.0.0/16 is directly connected, Serial0/0/0
L 172.17.0.1/32 is directly connected, Serial0/0/0
S 192.168.2.0/24 [1/0] via 172.16.0.1
S 192.168.3.0/24 [1/0] via 172.17.0.2
R2 #

R3 – Verification:

R3 # **show ip route**
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2
i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
ia - IS-IS inter area, * - candidate default, U - per-user static route
o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

C 172.17.0.0/16 is directly connected, Serial0/1
C 172.18.0.0/16 is directly connected, Serial0/0
S 10.0.0.0/8 [1/0] via 172.17.0.1
S 192.168.2.0/24 [1/0] via 172.18.0.2
C 192.168.3.0/24 is directly connected, FastEthernet0/0
R3 #

Verify communication between the networks

Verification from a Computer in R1 Network

ping 10.0.0.10

PING 10.0.0.10 (10.0.0.10) 56(84) bytes of data.
64 bytes from 10.0.0.10: icmp_seq=1 ttl=62 time=24.0 ms
64 bytes from 10.0.0.10: icmp_seq=2 ttl=62 time=24.0 ms
64 bytes from 10.0.0.10: icmp_seq=3 ttl=62 time=24.1 ms
64 bytes from 10.0.0.10: icmp_seq=4 ttl=62 time=24.0 ms

ping 192.168.3.10

PING 192.168.3.10 (192.168.3.10) 56(84) bytes of data.
64 bytes from 192.168.3.10: icmp_seq=25 ttl=62 time=24.1 ms
64 bytes from 192.168.3.10: icmp_seq=26 ttl=62 time=24.1 ms
64 bytes from 192.168.3.10: icmp_seq=27 ttl=62 time=24.3 ms
64 bytes from 192.168.3.10: icmp_seq=28 ttl=62 time=24.2 ms
64 bytes from 192.168.3.10: icmp_seq=29 ttl=62 time=24.2 ms

Repeat the above ping verification from a computer in R2 and R3 Network.

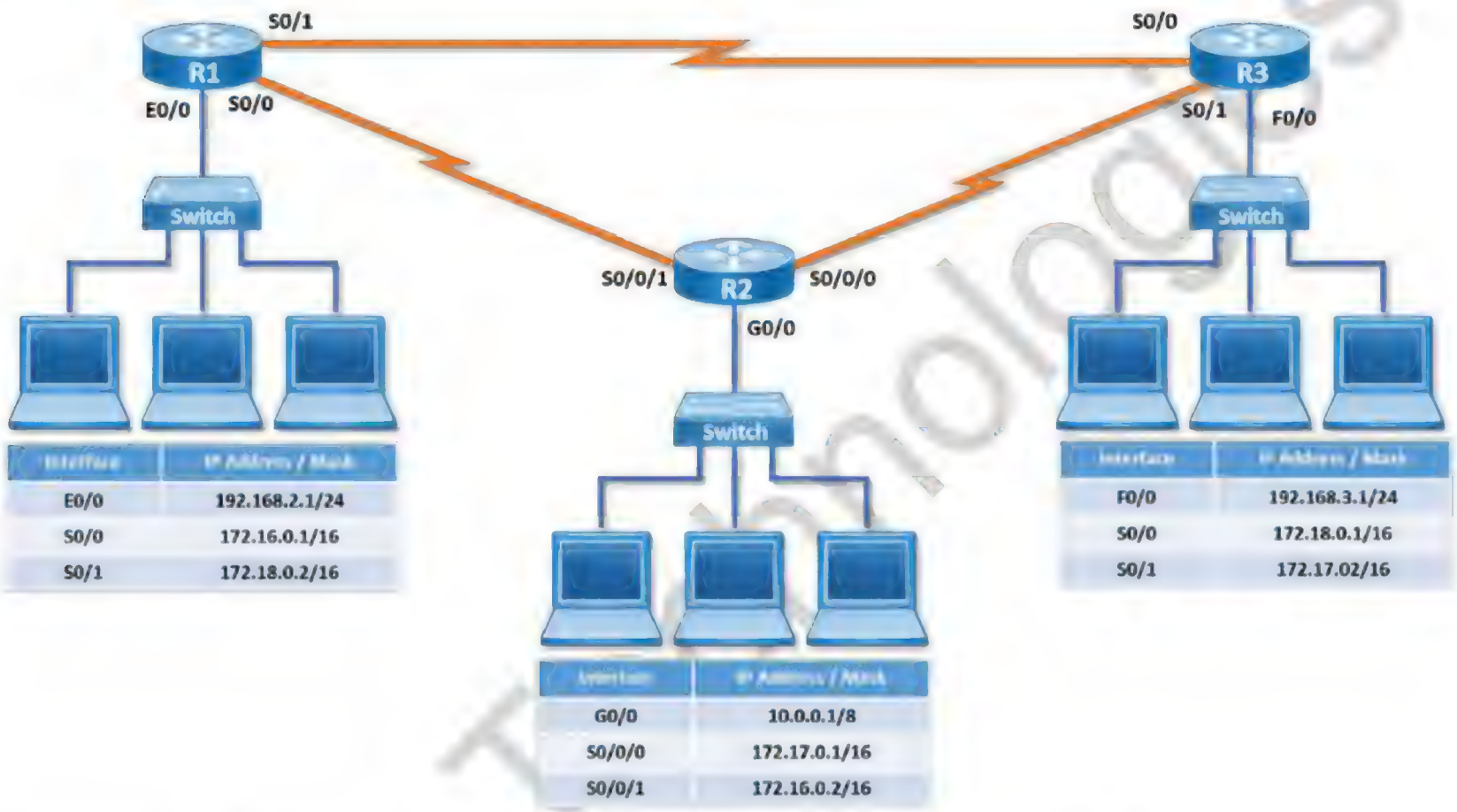
LAB 5: RIP ROUTING

OBJECTIVE:

To configure RIP Routing for communicating between different networks on different routers.

TOPOLOGY:

Setup Ethernet and Serial connectivity for the lab as below :



Interface	IP Address / Mask
E0/0	192.168.2.1/24
S0/0	172.16.0.1/16
S0/1	172.18.0.2/16

Interface	IP Address / Mask
G0/0	10.0.0.1/8
S0/0/0	172.17.0.1/16
S0/0/1	172.16.0.2/16

Interface	IP Address / Mask
F0/0	192.168.3.1/24
S0/0	172.18.0.1/16
S0/1	172.17.02/16

Pre-requisite: WAN Interface configuration to be done on the router (LAB – 3)

TASK:

- Configure RIP Routing
- Verify RIP Routing
- Verify Communication between the networks
- Verify RIP Update Packets

Configure RIP Routing

R1 – Configuration

R1 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R1 (config) # **ip routing**
R1 (config) # **router rip**
R1 (config-router) # **network 192.168.2.0**
R1 (config-router) # **network 172.16.0.0**
R1 (config-router) # **network 172.18.0.0**
R1 (config-router) # **end**
R1 (config) #

R2 – Configuration

R2 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R2 (config) # **ip routing**
R2 (config) # **router rip**
R2 (config-router) # **network 10.0.0.0**
R2 (config-router) # **network 172.16.0.0**
R2 (config-router) # **network 172.17.0.0**
R2 (config-router) # **end**
R2 (config) #

R3 – Configuration

R3 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R3 (config) # **ip routing**
R3 (config) # **router rip**
R3 (config-router) # **network 192.168.3.0**
R3 (config-router) # **network 172.17.0.0**
R3 (config-router) # **network 172.18.0.0**
R3 (config-router) # **end**
R3 (config) #

Verify RIP Routing

Once RIP routing is enabled, IP Networks learnt via **RIP** are added into the routing table. **"R"** represents **RIP route.**

R1 – Verification:

R1 # **show ip route**
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
* - candidate default, U - per-user static route, o - ODR
P - periodic downloaded static route

Gateway of last resort is not set

```
R    172.17.0.0/16 [120/1] via 172.16.0.2, 00:16:59, Serial0/0
                           [120/1] via 172.18.0.1, 00:16:59, Serial0/1
C    172.16.0.0/16 is directly connected, Serial0/0
C    172.18.0.0/16 is directly connected, Serial0/1
R    10.0.0.0/8 [120/1] via 172.16.0.2, 00:16:59, Serial0/0
C    192.168.2.0/24 is directly connected, Ethernet0/0
R    192.168.3.0/24 [120/1] via 172.18.0.1, 00:16:59, Serial0/1
R1 #
```

R2 – Verification:

R2 # **show ip route**
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2
i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
ia - IS-IS inter area, * - candidate default, U - per-user static route
o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
+ - replicated route, % - next hop override
Gateway of last resort is not set

```
     10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       10.0.0.0/8 is directly connected, GigabitEthernet0/0
L       10.0.0.1/32 is directly connected, GigabitEthernet0/0
     172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C       172.16.0.0/16 is directly connected, Serial0/0/1
L       172.16.0.2/32 is directly connected, Serial0/0/1
     172.17.0.0/16 is variably subnetted, 2 subnets, 2 masks
C       172.17.0.0/16 is directly connected, Serial0/0/0
L       172.17.0.1/32 is directly connected, Serial0/0/0
R    172.18.0.0/16 [120/1] via 172.17.0.2, 00:18:44, Serial0/0/0
                           [120/1] via 172.16.0.1, 00:18:44, Serial0/0/1
R    192.168.2.0/24 [120/1] via 172.16.0.1, 01:05:31, Serial0/0/1
R    192.168.3.0/24 [120/1] via 172.17.0.2, 00:18:44, Serial0/0/0
```

R2#

R3 – Verification:

R3 # **show ip route**
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2
i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
ia - IS-IS inter area, * - candidate default, U - per-user static route
o - ODR, P - periodic downloaded static route

Gateway of last resort is not set
C 172.17.0.0/16 is directly connected, Serial0/1
R 172.16.0.0/16 [120/1] via 172.18.0.2, 00:00:24, Serial0/0
[120/1] via 172.17.0.1, 00:00:24, Serial0/1
C 172.18.0.0/16 is directly connected, Serial0/0
R 10.0.0.0/8 [120/1] via 172.17.0.1, 00:00:24, Serial0/1
R 192.168.2.0/24 [120/1] via 172.18.0.2, 00:00:24, Serial0/0
C 192.168.3.0/24 is directly connected, FastEthernet0/0
R3#

Verify communication between the networks

Verification from a Computer in R1 Network

ping 10.0.0.10

PING 10.0.0.10 (10.0.0.10) 56(84) bytes of data.
64 bytes from 10.0.0.10: icmp_seq=1 ttl=62 time=24.0 ms
64 bytes from 10.0.0.10: icmp_seq=2 ttl=62 time=24.0 ms
64 bytes from 10.0.0.10: icmp_seq=3 ttl=62 time=24.1 ms
64 bytes from 10.0.0.10: icmp_seq=4 ttl=62 time=24.0 ms

ping 192.168.3.10

PING 192.168.3.10 (192.168.3.10) 56(84) bytes of data.
64 bytes from 192.168.3.10: icmp_seq=25 ttl=62 time=24.1 ms
64 bytes from 192.168.3.10: icmp_seq=26 ttl=62 time=24.1 ms
64 bytes from 192.168.3.10: icmp_seq=27 ttl=62 time=24.3 ms
64 bytes from 192.168.3.10: icmp_seq=28 ttl=62 time=24.2 ms
64 bytes from 192.168.3.10: icmp_seq=29 ttl=62 time=24.2 ms

Repeat the above ping verification from a computer in R2 and R3 Network.

Verify RIP Packets

Verify default behaviour of RIP Update packets by enabling debug commands

Example - R2

R2 # **terminal monitor**
R2 # **debug ip rip**

RIP protocol debugging is on
R2#RIP: received v1 update from 172.16.0.1 on Serial0/0/1
172.18.0.0 in 1 hops
192.168.2.0 in 1 hops
192.168.3.0 in 2 hops
RIP: sending v1 update to 255.255.255.255 via FastEthernet0/0 (10.0.0.1)
RIP: build update entries
network 172.16.0.0 metric 1
network 172.17.0.0 metric 1
network 172.18.0.0 metric 2
network 192.168.2.0 metric 2
network 192.168.3.0 metric 2
RIP: sending v1 update to 255.255.255.255 via Serial0/0/1 (172.16.0.2)
RIP: build update entries
network 10.0.0.0 metric 1
network 172.17.0.0 metric 1
network 192.168.3.0 metric 2
RIP: sending v1 update to 255.255.255.255 via Serial0/0/0 (172.17.0.1)
RIP: build update entries
network 10.0.0.0 metric 1
network 172.16.0.0 metric 1
network 192.168.2.0 metric 2

R2 # **undebug all**
R2 # **terminal no monitor**

LAB 6: EIGRP ROUTING

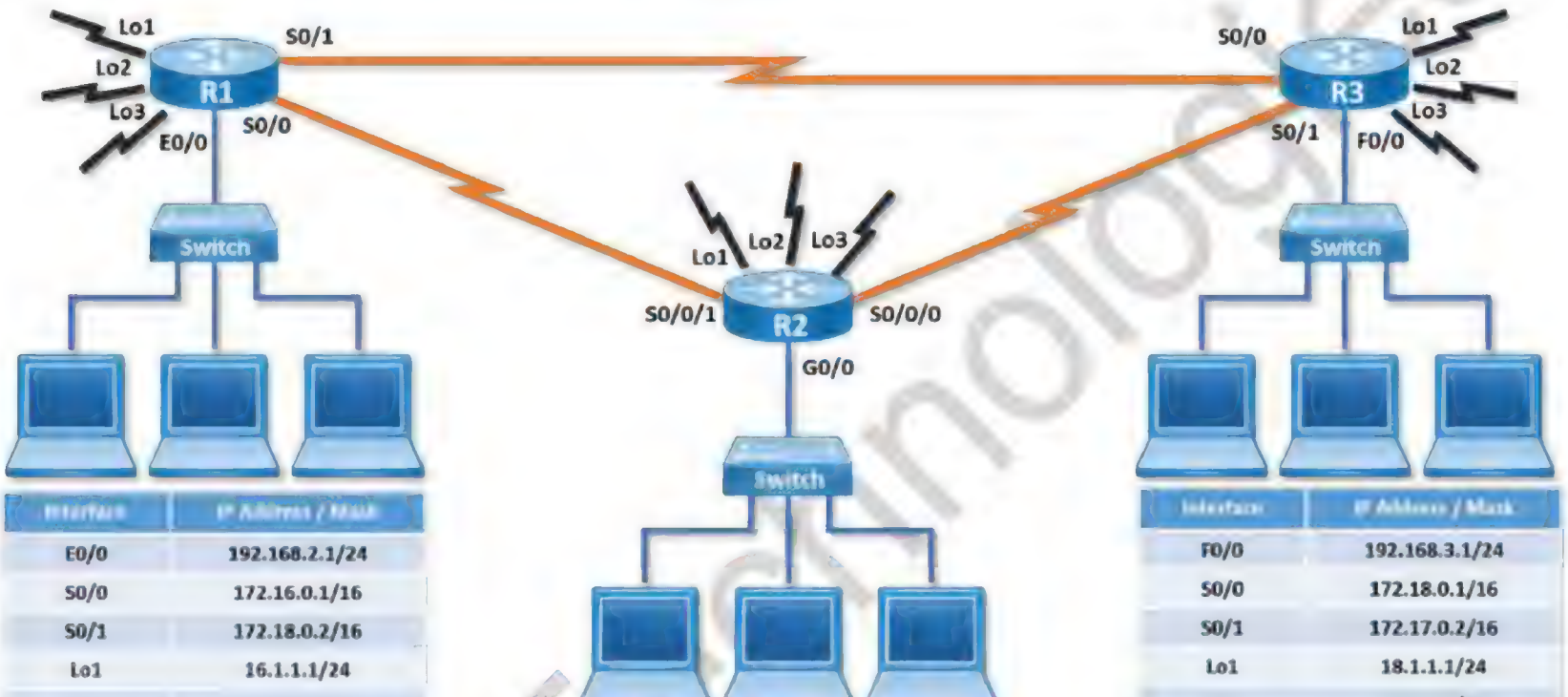
OBJECTIVE:

To configure EIGRP Routing for communicating between different networks on different routers.

To understand how EIGRP works and fine tune EIGRP configuration.

TOPOLOGY:

Setup Ethernet and Serial connectivity for the lab as below :



Interface	IP Address / Mask
E0/0	192.168.2.1/24
S0/0	172.16.0.1/16
S0/1	172.18.0.2/16
Lo1	16.1.1.1/24
Lo2	16.1.2.1/24
Lo3	16.1.3.1/24

Interface	IP Address / Mask
G0/0	10.0.0.1/8
S0/0/0	172.17.0.1/16
S0/0/1	172.16.0.2/16
Lo1	17.1.1.1/24
Lo2	17.1.2.1/24
Lo3	17.1.3.1/24

Interface	IP Address / Mask
F0/0	192.168.3.1/24
S0/0	172.18.0.1/16
S0/1	172.17.0.2/16
Lo1	18.1.1.1/24
Lo2	18.1.2.1/24
Lo3	18.1.3.1/24

Pre-requisite: WAN Interface configuration to be done on the router (LAB – 3)

TASK:

- Configure Loopback Interface
- Verify Loopback Interface
- Configure EIGRP Routing
- Verify EIGRP Routing
- Verify Communication between the networks
- Verify EIGRP Neighbour and Topology Table
- Verify EIGRP Packets
- Enable Passive Interface

- Disable Auto summary option

Configure Loopback Interface

Configure Loopback interface according to Lab Topology

R1 – Configuration

R1 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R1 (config)# **interface Lo 1**
R1 (config-if)# **ip address 16.1.1.1 255.255.255.0**
R1 (config)# **interface Lo 2**
R1 (config-if)# **ip address 16.1.2.1 255.255.255.0**
R1 (config)# **interface Lo 3**
R1 (config-if)# **ip address 16.1.3.1 255.255.255.0**
R1 (config-if)# **exit**

R2 – Configuration

R2 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R2 (config)# **interface Lo 1**
R2 (config-if)# **ip address 17.1.1.1 255.255.255.0**
R2 (config)# **interface Lo 2**
R2 (config-if)# **ip address 17.1.2.1 255.255.255.0**
R2 (config)# **interface Lo 3**
R2 (config-if)# **ip address 17.1.3.1 255.255.255.0**
R2 (config-if)# **exit**

R3 – Configuration

R3 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R3 (config)# **interface Lo 1**
R3 (config-if)# **ip address 18.1.1.1 255.255.255.0**
R3 (config)# **interface Lo 2**
R3 (config-if)# **ip address 18.1.2.1 255.255.255.0**
R3 (config)# **interface Lo 3**
R3 (config-if)# **ip address 18.1.3.1 255.255.255.0**
R3 (config-if)# **exit**

Verify Loopback Interface

R1 – Verification:

R1 # **show ip interface brief**

Interface	IP-Address	OK?	Method	Status	Protocol
Ethernet0/0	192.168.2.1	YES	NVRAM	up	up
Serial0/0	172.16.0.1	YES	NVRAM	up	up
Serial0/1	172.18.0.2	YES	NVRAM	up	up
Loopback1	16.1.1.1	YES	manual	up	up
Loopback2	16.1.2.1	YES	manual	up	up
Loopback3	16.1.3.1	YES	manual	up	up

R2 – Verification:

R2# **show ip interface brief**

Interface	IP-Address	OK?	Method	Status	Protocol
GigabitEthernet0/0	10.0.0.1	YES	NVRAM	up	up
GigabitEthernet0/1	unassigned	YES	NVRAM	administratively down	down
Serial0/0/0	172.17.0.1	YES	manual	up	up
Serial0/0/1	172.16.0.2	YES	manual	up	up
Loopback1	17.1.1.1	YES	manual	up	up
Loopback2	17.1.2.1	YES	manual	up	up
Loopback3	17.1.3.1	YES	manual	up	up

R3 – Verification:

R2# **show ip interface brief**

Interface	IP-Address	OK?	Method	Status	Protocol
FastEthernet0/0	192.168.3.1	YES	NVRAM	up	up
Serial0/0	172.18.0.1	YES	NVRAM	up	up
FastEthernet0/1	unassigned	YES	NVRAM	administratively down	down
Serial0/1	172.17.0.2	YES	NVRAM	up	up
Loopback1	18.1.1.1	YES	manual	up	up
Loopback2	18.1.2.1	YES	manual	up	up
Loopback3	18.1.3.1	YES	manual	up	up

Configure EIGRP Routing

R1 – Configuration

R1 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R1 (config) # **ip routing**
R1 (config) # **router eigrp 10**
R1 (config-router) # **network 192.168.2.0**
R1 (config-router) # **network 172.16.0.0**
R1 (config-router) # **network 172.18.0.0**
R1 (config-router) # **network 16.0.0.0**
R1 (config-router) # **end**
R1 (config) #

R2 – Configuration

R2 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R2 (config) # **ip routing**
R2 (config) # **router eigrp 10**
R2 (config-router) # **network 10.0.0.0**
R2 (config-router) # **network 172.16.0.0**
R2 (config-router) # **network 172.17.0.0**
R2 (config-router) # **network 17.0.0.0**
R2 (config-router) # **end**
R2 (config) #

R3 – Configuration

R3 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R3 (config) # **ip routing**
R3 (config) # **router eigrp 10**
R3 (config-router) # **network 192.168.3.0**
R3 (config-router) # **network 172.17.0.0**
R3 (config-router) # **network 172.18.0.0**
R3 (config-router) # **network 18.0.0.0**
R3 (config-router) # **end**
R3 (config) #

Verify EIGRP Routing

Once EIGRP routing is enabled, IP Networks learnt via **EIGRP** are added into the routing table. **"D"** represents **EIGRP route.**

R1 – Verification:

R1 # **show ip route**
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
* - candidate default, U - per-user static route, o - ODR
P - periodic downloaded static route

Gateway of last resort is not set

17.0.0.0/24 is subnetted, 3 subnets
D 17.1.1.0 [90/2297856] via 172.16.0.2, 00:16:59, Serial0/0
D 17.1.2.0 [90/2297856] via 172.16.0.2, 00:16:59, Serial0/0
D 17.1.3.0 [90/2297856] via 172.16.0.2, 00:16:59, Serial0/0
16.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
D 16.0.0.0/8 is a summary, 00:16:59, Null0
C 16.1.1.0/24 is directly connected, Loopback1
C 16.1.3.0/24 is directly connected, Loopback3
C 16.1.2.0/24 is directly connected, Loopback2
D 18.0.0.0/8 [90/2297856] via 172.18.0.1, 00:16:59, Serial0/1
D 172.17.0.0/16 [90/2681856] via 172.16.0.2, 00:16:59, Serial0/0
[90/2681856] via 172.18.0.1, 00:16:59, Serial0/1
C 172.16.0.0/16 is directly connected, Serial0/0
C 172.18.0.0/16 is directly connected, Serial0/1
D 10.0.0.0/8 [90/2172416] via 172.16.0.2, 00:16:59, Serial0/0
C 192.168.2.0/24 is directly connected, Ethernet0/0
D 192.168.3.0/24 [90/2172416] via 172.18.0.1, 00:16:59, Serial0/1
R1 #

R2 – Verification:

R2 # **show ip route**
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2
i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
ia - IS-IS inter area, * - candidate default, U - per-user static route
o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
+ - replicated route, % - next hop override

Gateway of last resort is not set
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C 10.0.0.0/8 is directly connected, GigabitEthernet0/0

```
L      10.0.0.1/32 is directly connected, GigabitEthernet0/0
D    16.0.0.0/8 [90/896000] via 172.16.0.1, 01:05:31, Serial0/0/1
     17.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
C      17.1.1.0/24 is directly connected, Loopback1
L      17.1.1.1/32 is directly connected, Loopback1
C      17.1.2.0/24 is directly connected, Loopback2
L      17.1.2.1/32 is directly connected, Loopback2
C      17.1.3.0/24 is directly connected, Loopback3
L      17.1.3.1/32 is directly connected, Loopback3
D    18.0.0.0/8 [90/896000] via 172.17.0.2, 00:18:44, Serial0/0/0
     172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C      172.16.0.0/16 is directly connected, Serial0/0/1
L      172.16.0.2/32 is directly connected, Serial0/0/1
     172.17.0.0/16 is variably subnetted, 2 subnets, 2 masks
C      172.17.0.0/16 is directly connected, Serial0/0/0
L      172.17.0.1/32 is directly connected, Serial0/0/0
D    172.18.0.0/16 [90/2681856] via 172.17.0.2, 00:18:44, Serial0/0/0
                   [90/2681856] via 172.16.0.1, 00:18:44, Serial0/0/1
D    192.168.2.0/24 [90/793600] via 172.16.0.1, 01:05:31, Serial0/0/1
D    192.168.3.0/24 [90/770560] via 172.17.0.2, 00:18:44, Serial0/0/0
R2#
```

R3 – Verification:

R3 # **show ip route**

```
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set
     17.0.0.0/24 is subnetted, 3 subnets
D       17.1.1.0 [90/2297856] via 172.17.0.1, 00:00:24, Serial0/1
D       17.1.2.0 [90/2297856] via 172.17.0.1, 00:00:24, Serial0/1
D       17.1.3.0 [90/2297856] via 172.17.0.1, 00:00:24, Serial0/1
D    16.0.0.0/8 [90/2297856] via 172.18.0.2, 00:00:24, Serial0/0
     18.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
C       18.1.3.0/24 is directly connected, Loopback3
C       18.1.2.0/24 is directly connected, Loopback2
C       18.1.1.0/24 is directly connected, Loopback1
D       18.0.0.0/8 is a summary, 00:00:13, Null0
C    172.17.0.0/16 is directly connected, Serial0/1
D    172.16.0.0/16 [90/2681856] via 172.18.0.2, 00:00:24, Serial0/0
                   [90/2681856] via 172.17.0.1, 00:00:24, Serial0/1
C    172.18.0.0/16 is directly connected, Serial0/0
D    10.0.0.0/8 [90/2172416] via 172.17.0.1, 00:00:24, Serial0/1
D    192.168.2.0/24 [90/2195456] via 172.18.0.2, 00:00:24, Serial0/0
C    192.168.3.0/24 is directly connected, FastEthernet0/0
```

R3#

Verify communication between the networks

Verification from a Computer in R1 Network

ping 10.0.0.10

PING 10.0.0.10 (10.0.0.10) 56(84) bytes of data.
64 bytes from 10.0.0.10: icmp_seq=1 ttl=62 time=24.0 ms
64 bytes from 10.0.0.10: icmp_seq=2 ttl=62 time=24.0 ms
64 bytes from 10.0.0.10: icmp_seq=3 ttl=62 time=24.1 ms
64 bytes from 10.0.0.10: icmp_seq=4 ttl=62 time=24.0 ms

ping 192.168.3.10

PING 192.168.3.10 (192.168.3.10) 56(84) bytes of data.
64 bytes from 192.168.3.10: icmp_seq=25 ttl=62 time=24.1 ms
64 bytes from 192.168.3.10: icmp_seq=26 ttl=62 time=24.1 ms
64 bytes from 192.168.3.10: icmp_seq=27 ttl=62 time=24.3 ms
64 bytes from 192.168.3.10: icmp_seq=28 ttl=62 time=24.2 ms
64 bytes from 192.168.3.10: icmp_seq=29 ttl=62 time=24.2 ms

Repeat the above ping verification from a computer in R2 and R3 Network.

Verify EIGRP Neighbour and Topology Table

R1 – Verification:

R1 # **show ip eigrp neighbor**
IP-EIGRP neighbors for process 10

H	Address	Interface	Hold (sec)	Uptime (ms)	SRTT	RTO	Q Cnt	Seq Num	Type
1	172.18.0.1	Se0/1	10	00:07:26	69	414	0	13	
0	172.16.0.2	Se0/0	11	00:54:13	25	200	0	15	

R1#

R1 # **show ip eigrp topology**
IP-EIGRP Topology Table for AS(10)/ID(16.1.3.1)

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
r - Reply status

P 10.0.0.0/8, 1 successors, FD is 2172416
via 172.16.0.2 (2172416/28160), Serial0/0
via 172.18.0.1 (2684416/770560), Serial0/1
P 16.0.0.0/8, 1 successors, FD is 128256
via Summary (128256/0), Null0
P 16.1.1.0/24, 1 successors, FD is 128256
via Connected, Loopback1
P 17.1.1.0/24, 1 successors, FD is 2297856
via 172.16.0.2 (2297856/128256), Serial0/0
via 172.18.0.1 (2809856/896000), Serial0/1
P 17.1.2.0/24, 1 successors, FD is 2297856
via 172.16.0.2 (2297856/128256), Serial0/0
via 172.18.0.1 (2809856/896000), Serial0/1
P 18.0.0.0/8, 1 successors, FD is 2297856
via 172.18.0.1 (2297856/128256), Serial0/1
via 172.16.0.2 (2809856/896000), Serial0/0
P 16.1.3.0/24, 1 successors, FD is 128256
via Connected, Loopback3
P 17.1.3.0/24, 1 successors, FD is 2297856
via 172.16.0.2 (2297856/128256), Serial0/0
via 172.18.0.1 (2809856/896000), Serial0/1
P 16.1.2.0/24, 1 successors, FD is 128256
via Connected, Loopback2
P 192.168.2.0/24, 1 successors, FD is 281600
via Connected, Ethernet0/0
P 192.168.3.0/24, 1 successors, FD is 2172416
via 172.18.0.1 (2172416/28160), Serial0/1
via 172.16.0.2 (2684416/770560), Serial0/0
P 172.16.0.0/16, 1 successors, FD is 2169856
via Connected, Serial0/0
via 172.18.0.1 (3193856/1280000), Serial0/1

P 172.17.0.0/16, 2 successors, FD is 2681856
via 172.18.0.1 (2681856/768000), Serial0/1
via 172.16.0.2 (2681856/768000), Serial0/0
P 172.18.0.0/16, 1 successors, FD is 2169856
via Connected, Serial0/1

R1 #

R2 – Verification:

R2 # **show ip eigrp neighbor**
EIGRP-IPv4 Neighbors for AS(10)

H	Address	Interface	Hold (sec)	Uptime (ms)	SRTT	RTO	Q Cnt	Seq Num	Type
1	172.16.0.1	Se0/0/1	13	01:06:11	28	200	0	7	
0	172.17.0.2	Se0/0/0	14	01:09:47	26	200	0	10	

R2#

R2 # **show ip eigrp topology**
EIGRP-IPv4 Topology Table for AS(10)/ID(17.1.3.1)

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
r - reply Status, s - sia Status

P 192.168.3.0/24, 1 successors, FD is 770560
via 172.17.0.2 (770560/28160), Serial0/0/0
P 192.168.2.0/24, 1 successors, FD is 793600
via 172.16.0.1 (793600/281600), Serial0/0/1
P 17.1.2.0/24, 1 successors, FD is 128256
via Connected, Loopback2
P 172.16.0.0/16, 1 successors, FD is 768000
via Connected, Serial0/0/1
P 10.0.0.0/8, 1 successors, FD is 28160
via Connected, GigabitEthernet0/0
P 172.18.0.0/16, 2 successors, FD is 2681856
via 172.16.0.1 (2681856/2169856), Serial0/0/1
via 172.17.0.2 (2681856/2169856), Serial0/0/0
P 17.1.3.0/24, 1 successors, FD is 128256
via Connected, Loopback3
P 172.17.0.0/16, 1 successors, FD is 768000
via Connected, Serial0/0/0
P 18.0.0.0/8, 1 successors, FD is 896000
via 172.17.0.2 (896000/128256), Serial0/0/0
P 16.0.0.0/8, 1 successors, FD is 896000
via 172.16.0.1 (896000/128256), Serial0/0/1
P 17.1.1.0/24, 1 successors, FD is 128256
via Connected, Loopback1

R2#

R3 – Verification:

R3 # **show ip eigrp neighbor**

IP-EIGRP neighbors for process 10

H	Address	Interface	Hold	Uptime	SRTT	RTO	Q	Seq	Type
		(sec)		(ms)		Cnt	Num		
1	172.17.0.1	Se0/1	13	00:00:53	69	200	0	11	
0	172.18.0.2	Se0/0	13	00:01:02	411	2466	0	12	

R3#

R3 # **show ip eigrp topology**

IP-EIGRP Topology Table for AS(10)/ID(18.1.3.1)

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
r - reply Status, s - sia Status

P 10.0.0.0/8, 1 successors, FD is 2172416
via 172.17.0.1 (2172416/28160), Serial0/1
P 18.1.3.0/24, 1 successors, FD is 128256
via Connected, Loopback3
P 16.0.0.0/8, 1 successors, FD is 2297856
via 172.18.0.2 (2297856/128256), Serial0/0
P 18.1.2.0/24, 1 successors, FD is 128256
via Connected, Loopback2
P 17.1.1.0/24, 1 successors, FD is 2297856
via 172.17.0.1 (2297856/128256), Serial0/1
P 18.0.0.0/8, 1 successors, FD is 128256
via Summary (128256/0), Null0
P 18.1.1.0/24, 1 successors, FD is 128256
via Connected, Loopback1
P 17.1.2.0/24, 1 successors, FD is 2297856
via 172.17.0.1 (2297856/128256), Serial0/1
P 17.1.3.0/24, 1 successors, FD is 2297856
via 172.17.0.1 (2297856/128256), Serial0/1
P 192.168.2.0/24, 1 successors, FD is 2195456
via 172.18.0.2 (2195456/281600), Serial0/0
P 192.168.3.0/24, 1 successors, FD is 28160
via Connected, FastEthernet0/0
P 172.16.0.0/16, 2 successors, FD is 2681856
via 172.17.0.1 (2681856/2169856), Serial0/1
via 172.18.0.2 (2681856/2169856), Serial0/0
P 172.17.0.0/16, 1 successors, FD is 2169856
via Connected, Serial0/1
P 172.18.0.0/16, 1 successors, FD is 2169856
via Connected, Serial0/0
R3#

Verify EIGRP Packets

Verify default behaviour of EIGRP Hello / Update packets by enabling debug commands

Example - R2

R2 # **terminal monitor**
R2 # **debug eigrp packet**

(UPDATE, REQUEST, QUERY, REPLY, HELLO, IPXSAP, PROBE, ACK, STUB, SIAQUERY, SIAREPLY)

EIGRP Packet debugging is on
*Jul 21 17:57:04.245: EIGRP: Packet from ourselves ignored
*Jul 21 17:57:04.861: EIGRP: Sending HELLO on Serial0/0/0
*Jul 21 17:57:04.861: AS 10, Flags 0x0:(NULL), Seq 0/0 interfaceQ 0/0 iidbQ un/rely 0/0
*Jul 21 17:57:04.909: EIGRP: Sending HELLO on Serial0/0/1
*Jul 21 17:57:04.909: AS 10, Flags 0x0:(NULL), Seq 0/0 interfaceQ 0/0 iidbQ un/rely 0/0
*Jul 21 17:57:04.917: EIGRP: Received HELLO on Serial0/0/1 nbr 172.16.0.1
*Jul 21 17:57:04.917: AS 10, Flags 0x0:(NULL), Seq 0/0 interfaceQ 0/0 iidbQ un/rely 0/0 peerQ un/rely 0/0
*Jul 21 17:57:05.621: EIGRP: Received HELLO on Serial0/0/0 nbr 172.17.0.2
*Jul 21 17:57:05.621: AS 10, Flags 0x0:(NULL), Seq 0/0 interfaceQ 0/0 iidbQ un/rely 0/0 peerQ un/rely 0/0
*Jul 21 17:57:05.793: EIGRP: Received HELLO on GigabitEthernet0/0 nbr 192.168.3.1
*Jul 21 17:57:05.793: AS 10, Flags 0x0:(NULL), Seq 0/0 interfaceQ 0/0
*Jul 21 17:57:05.793: EIGRP-IPv4(10): Neighbor 192.168.3.1 not on common subnet for GigabitEthernet0/0
*Jul 21 17:57:06.949: EIGRP: Received HELLO on GigabitEthernet0/0 nbr 192.168.2.1
*Jul 21 17:57:06.949: AS 10, Flags 0x0:(NULL), Seq 0/0 interfaceQ 0/0
*Jul 21 17:57:07.317: EIGRP: Sending HELLO on Loopback1
*Jul 21 17:57:07.317: AS 10, Flags 0x0:(NULL), Seq 0/0 interfaceQ 0/0 iidbQ un/rely 0/0
*Jul 21 17:57:07.317: EIGRP: Received HELLO on Loopback1 nbr 17.1.1.1
*Jul 21 17:57:07.317: AS 10, Flags 0x0:(NULL), Seq 0/0 interfaceQ 0/0
*Jul 21 17:57:07.317: EIGRP: Packet from ourselves ignored
*Jul 21 17:57:07.409: EIGRP: Sending HELLO on GigabitEthernet0/0
*Jul 21 17:57:07.409: AS 10, Flags 0x0:(NULL), Seq 0/0 interfaceQ 0/0 iidbQ un/rely 0/0
!
<output omitted>
!
*Jul 21 17:57:12.109: EIGRP: Packet from ourselves ignored
*Jul 21 17:57:12.201: EIGRP: Sending HELLO on GigabitEthernet0/0
*Jul 21 17:57:12.201: AS 10, Flags 0x0:(NULL), Seq 0/0 interfaceQ 0/0 iidbQ un/rely 0/0
*Jul 21 17:57:12.437: EIGRP: Sending HELLO on Loopback3

R2 # **undebug all**
R2 # **terminal no monitor**

Enabling Passive Interface

To disable sending of EIGRP hello / updates packet on selected Interface. (i.e. Ethernet Interface)we use the passive interface command.

Example - R2

R2# **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R2 (config) # **router eigrp 10**
R2 (config-router) # **passive-interface Gigabitethernet 0/0**
R2 (config-router) # **end**

R2 – Verification:

After enabling passive interface, again verify the behaviour of EIGRP Hello / Update packets by enabling debug commands. Now you will not see the following line in the debug outputs.

EIGRP: Sending HELLO on GigabitEthernet0/0

This means you have successfully disabled sending of EIGRP hello / updates packet on selected Interface.

Disabling EIGRP Auto Summary

By default EIGRP auto summary is enabled on CISCO IOS prior to 12.4. Let's try to understand the difference in routing table output when auto summary is enabled and when it is disabled.

Verify Routing Table on R2

R2 # **show ip route**
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2
i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
ia - IS-IS inter area, * - candidate default, U - per-user static route
o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
+ - replicated route, % - next hop override

Gateway of last resort is not set

10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C 10.0.0.0/8 is directly connected, GigabitEthernet0/0
L 10.0.0.1/32 is directly connected, GigabitEthernet0/0
D 16.0.0.0/8 [90/2297856] via 172.16.0.1, 00:20:38, Serial0/0/1
17.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
C 17.1.1.0/24 is directly connected, Loopback1

```
L       17.1.1.1/32 is directly connected, Loopback1
C       17.1.2.0/24 is directly connected, Loopback2
L       17.1.2.1/32 is directly connected, Loopback2
C       17.1.3.0/24 is directly connected, Loopback3
L       17.1.3.1/32 is directly connected, Loopback3
D    18.0.0.0/8 [90/2297856] via 172.17.0.2, 00:20:37, Serial0/0/0
     172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C       172.16.0.0/16 is directly connected, Serial0/0/1
L       172.16.0.2/32 is directly connected, Serial0/0/1
     172.17.0.0/16 is variably subnetted, 2 subnets, 2 masks
C       172.17.0.0/16 is directly connected, Serial0/0/0
L       172.17.0.1/32 is directly connected, Serial0/0/0
D    172.18.0.0/16 [90/2681856] via 172.17.0.2, 00:20:43, Serial0/0/0
                   [90/2681856] via 172.16.0.1, 00:20:43, Serial0/0/1
D    192.168.2.0/24 [90/2195456] via 172.16.0.1, 00:20:38, Serial0/0/1
D    192.168.3.0/24 [90/2172416] via 172.17.0.2, 00:20:38, Serial0/0/0
R2#
```

Disable Auto Summary on R1

R1 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R1 (config) # **router eigrp 10**
R1 (config-router)# **no auto-summary**
R1 (config-router)# **end**

Verify Routing Table on R2

R2 # **show ip route**

```
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

     10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       10.0.0.0/8 is directly connected, GigabitEthernet0/0
L       10.0.0.1/32 is directly connected, GigabitEthernet0/0
     16.0.0.0/24 is subnetted, 3 subnets
D       16.1.1.0 [90/2297856] via 172.16.0.1, 00:00:07, Serial0/0/1
D       16.1.2.0 [90/2297856] via 172.16.0.1, 00:00:07, Serial0/0/1
D       16.1.3.0 [90/2297856] via 172.16.0.1, 00:00:07, Serial0/0/1
     17.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
C       17.1.1.0/24 is directly connected, Loopback1
L       17.1.1.1/32 is directly connected, Loopback1
```

```
C       17.1.2.0/24 is directly connected, Loopback2
L       17.1.2.1/32 is directly connected, Loopback2
C       17.1.3.0/24 is directly connected, Loopback3
L       17.1.3.1/32 is directly connected, Loopback3
D    18.0.0.0/8 [90/2297856] via 172.17.0.2, 00:00:07, Serial0/0/0
     172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C       172.16.0.0/16 is directly connected, Serial0/0/1
L       172.16.0.2/32 is directly connected, Serial0/0/1
     172.17.0.0/16 is variably subnetted, 2 subnets, 2 masks
C       172.17.0.0/16 is directly connected, Serial0/0/0
L       172.17.0.1/32 is directly connected, Serial0/0/0
D    172.18.0.0/16 [90/2681856] via 172.17.0.2, 00:00:07, Serial0/0/0
                   [90/2681856] via 172.16.0.1, 00:00:07, Serial0/0/1
D    192.168.2.0/24 [90/2195456] via 172.16.0.1, 00:00:07, Serial0/0/1
D    192.168.3.0/24 [90/2172416] via 172.17.0.2, 00:00:07, Serial0/0/0
R2 #
```

LAB 7: OSPF ROUTING - Single Area

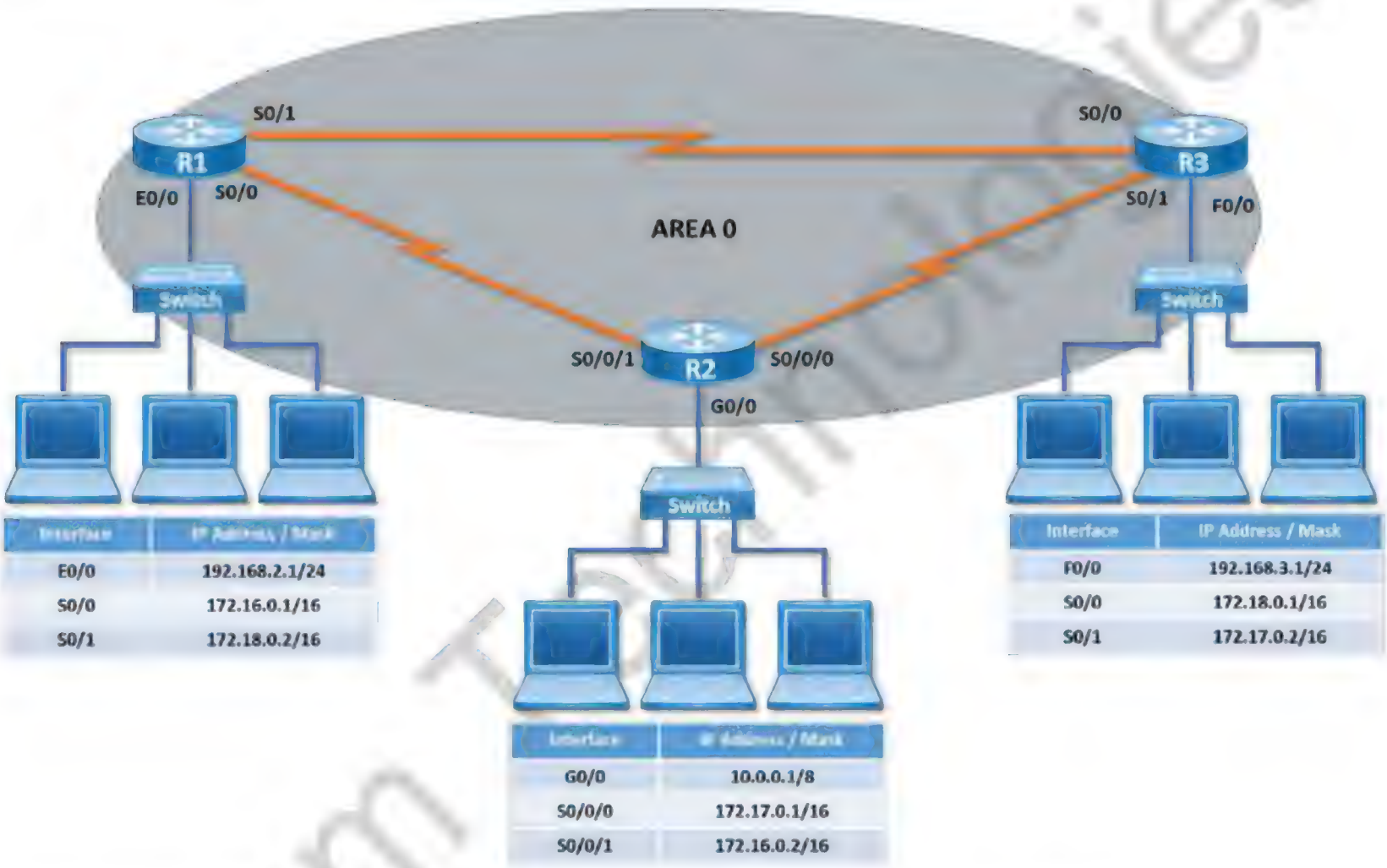
OBJECTIVE:

To configure OSPF Routing in a single area.

To understand how OSPF works and fine tune OSPF configuration.

TOPOLOGY:

Setup Ethernet and Serial connectivity for the lab as below:



Interface	IP Address / Mask
E0/0	192.168.2.1/24
S0/0	172.16.0.1/16
S0/1	172.18.0.2/16

Interface	IP Address / Mask
F0/0	192.168.3.1/24
S0/0	172.18.0.1/16
S0/1	172.17.0.2/16

Interface	IP Address / Mask
G0/0	10.0.0.1/8
S0/0/0	172.17.0.1/16
S0/0/1	172.16.0.2/16

Pre-requisite: WAN Interface configuration to be done on the router (LAB – 3)

TASK:

- Configure OSPF Routing – Single Area
- Verify OSPF Routing – Single Area
- Verify Communication between the networks
- Verify OSPF Neighbour and Topology Table
- Verify OSPF Packets
- Enable Passive Interface

Configure OSPF Routing – Single Area

R1 – Configuration

R1 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R1 (config) # **ip routing**
R1 (config) # **router ospf 1**
R1 (config-router) # **network 192.168.2.0 0.0.0.255 area 0**
R1 (config-router) # **network 172.16.0.0 0.0.255.255 area 0**
R1 (config-router) # **network 172.18.0.0 0.0.255.255 area 0**
R1 (config-router) # **end**
R1 (config) #

R2 – Configuration

R2 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R2 (config) # **ip routing**
R2 (config) # **router ospf 2**
R2 (config-router) # **network 10.0.0.0 0.255.255.255 area 0**
R2 (config-router) # **network 172.16.0.0 0.0.255.255 area 0**
R2 (config-router) # **network 172.17.0.0 0.0.255.255 area 0**
R2 (config-router) # **end**
R2 (config) #

R3 – Configuration

R3 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R3 (config) # **ip routing**
R3 (config) # **router ospf 3**
R3 (config-router) # **network 192.168.3.0 0.0.0.255 area 0**
R3 (config-router) # **network 172.17.0.0 0.0.255.255 area 0**
R3 (config-router) # **network 172.18.0.0 0.0.255.255 area 0**
R3 (config-router) # **end**
R3 (config) #

Verify OSPF Routing – Single Area

Once OSPF routing is enabled,the IP Networkslearned through **OSPF** are added into the routing table. **"O"** represents an**OSPF route.**

R1 – Verification:

R1 # **show ip route**

Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
* - candidate default, U - per-user static route, o - ODR
P - periodic downloaded static route

Gateway of last resort is not set

O 172.17.0.0/16 [110/128] via 172.16.0.2, 00:00:01, Serial0/0
[110/128] via 172.18.0.1, 00:00:01, Serial0/1
C 172.16.0.0/16 is directly connected, Serial0/0
C 172.18.0.0/16 is directly connected, Serial0/1
O 10.0.0.0/8 [110/65] via 172.16.0.2, 00:00:01, Serial0/0
C 192.168.2.0/24 is directly connected, Ethernet0/0
O 192.168.3.0/24 [110/65] via 172.18.0.1, 00:00:01, Serial0/1
R1 #

R2 – Verification:

R2 # **show ip route**

Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2
i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
ia - IS-IS inter area, * - candidate default, U - per-user static route
o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
+ - replicated route, % - next hop override

Gateway of last resort is not set

10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C 10.0.0.0/8 is directly connected, GigabitEthernet0/0
L 10.0.0.1/32 is directly connected, GigabitEthernet0/0
172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C 172.16.0.0/16 is directly connected, Serial0/0/1
L 172.16.0.2/32 is directly connected, Serial0/0/1

```
     172.17.0.0/16 is variably subnetted, 2 subnets, 2 masks
C       172.17.0.0/16 is directly connected, Serial0/0/0
L       172.17.0.1/32 is directly connected, Serial0/0/0
O    172.18.0.0/16 [110/128] via 172.17.0.2, 00:00:51, Serial0/0/0
                   [110/128] via 172.16.0.1, 00:01:55, Serial0/0/1
O    192.168.2.0/24 [110/74] via 172.16.0.1, 00:01:55, Serial0/0/1
O    192.168.3.0/24 [110/65] via 172.17.0.2, 00:01:01, Serial0/0/0
R2 #
```

R3 – Verification:

```
R3 # show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

C    172.17.0.0/16 is directly connected, Serial0/1
O    172.16.0.0/16 [110/128] via 172.18.0.2, 00:01:48, Serial0/0
                   [110/128] via 172.17.0.1, 00:01:48, Serial0/1
C    172.18.0.0/16 is directly connected, Serial0/0
O    10.0.0.0/8 [110/65] via 172.17.0.1, 00:01:48, Serial0/1
O    192.168.2.0/24 [110/74] via 172.18.0.2, 00:01:48, Serial0/0
C    192.168.3.0/24 is directly connected, FastEthernet0/0
R3 #
```

Verify communication between the networks

Verification from a Computer in R1 Network

ping 10.0.0.10

PING 10.0.0.10 (10.0.0.10) 56(84) bytes of data.
64 bytes from 10.0.0.10: icmp_seq=1 ttl=62 time=24.0 ms
64 bytes from 10.0.0.10: icmp_seq=2 ttl=62 time=24.0 ms
64 bytes from 10.0.0.10: icmp_seq=3 ttl=62 time=24.1 ms
64 bytes from 10.0.0.10: icmp_seq=4 ttl=62 time=24.0 ms

ping 192.168.3.10

PING 192.168.3.10 (192.168.3.10) 56(84) bytes of data.
64 bytes from 192.168.3.10: icmp_seq=25 ttl=62 time=24.1 ms
64 bytes from 192.168.3.10: icmp_seq=26 ttl=62 time=24.1 ms
64 bytes from 192.168.3.10: icmp_seq=27 ttl=62 time=24.3 ms
64 bytes from 192.168.3.10: icmp_seq=28 ttl=62 time=24.2 ms
64 bytes from 192.168.3.10: icmp_seq=29 ttl=62 time=24.2 ms

Repeat the above ping verification from a computer in R2 and R3 Network.

Verify OSPF Neighbour and Database Table

R1 – Verification:

R1 # **show ip ospf neighbor**

Neighbor ID	Pri	State	Dead Time	Address	Interface
172.17.0.1	1	FULL/ -	00:00:31	172.16.0.2	Serial0/0
192.168.3.1	1	FULL/ -	00:00:34	172.18.0.1	Serial0/1

R1 #

R1 # **show ip ospf database**

OSPF Router with ID (192.168.2.1) (Process ID 1)

Router Link States (Area 0)

Link ID	ADV Router	Age	Seq#	Checksum	Link count
172.17.0.1	172.17.0.1	56	0x80000005	0x385F	5
192.168.2.1	192.168.2.1	48	0x80000005	0xD3A9	5
192.168.3.1	192.168.3.1	46	0x80000004	0x87B	5

R1 #

R2 – Verification:

R2 # **show ip ospf neighbor**

Neighbor ID	Pri	State	Dead Time	Address	Interface
192.168.3.1	0	FULL/ -	00:00:39	172.17.0.2	Serial0/0/0
192.168.2.1	0	FULL/ -	00:00:32	172.16.0.1	Serial0/0/1

R2 #

R2 # **show ip ospf database**

OSPF Router with ID (172.17.0.1) (Process ID 2)

Router Link States (Area 0)

Link ID	ADV Router	Age	Seq#	Checksum	Link count
172.17.0.1	172.17.0.1	56	0x80000005	0x385F	5
192.168.2.1	192.168.2.1	48	0x80000005	0xD3A9	5
192.168.3.1	192.168.3.1	46	0x80000004	0x87B	5

R2 #

R3 – Verification:

R3 # **show ip ospf neighbor**

Neighbor ID	Pri	State	Dead Time	Address	Interface
192.168.2.1	0	FULL/ -	00:00:38	172.18.0.2	Serial0/0
172.17.0.1	0	FULL/ -	00:00:34	172.17.0.1	Serial0/1

R3 #

R3 # **show ip ospf database**

OSPF Router with ID (192.168.3.1) (Process ID 3)

Router Link States (Area 0)

Link ID	ADV Router	Age	Seq#	Checksum	Link count
172.17.0.1	172.17.0.1	176	0x80000005	0x385F	5
192.168.2.1	192.168.2.1	169	0x80000005	0xD3A9	5
192.168.3.1	192.168.3.1	165	0x80000004	0x87B	5

R3 #

Verify OSPF Hello Packets

Verify default behaviour of OSPF Hello packets by enabling debug commands

Example - R2

R2 # **terminal monitor**
R2 # **debug ip ospf hello**
OSPF hello events debugging is on
R2#
*Jul 22 20:00:44.967: OSPF: Rcv hello from 192.168.3.1 area 0 from Serial0/0/0 172.17.0.2
*Jul 22 20:00:44.967: OSPF: End of hello processing
*Jul 22 20:00:46.011: OSPF: Send hello to 224.0.0.5 area 0 on GigabitEthernet0/0 from 10.0.0.1
*Jul 22 20:00:47.959: OSPF: Rcv hello from 192.168.2.1 area 0 from Serial0/0/1 172.16.0.1
*Jul 22 20:00:47.959: OSPF: End of hello processing
*Jul 22 20:00:49.779: OSPF: Send hello to 224.0.0.5 area 0 on Serial0/0/0 from 172.17.0.1
*Jul 22 20:00:51.263: OSPF: Send hello to 224.0.0.5 area 0 on Serial0/0/1 from 172.16.0.2
*Jul 22 20:00:54.967: OSPF: Rcv hello from 192.168.3.1 area 0 from Serial0/0/0 172.17.0.2
*Jul 22 20:00:54.967: OSPF: End of hello processing
*Jul 22 20:00:55.279: OSPF: Send hello to 224.0.0.5 area 0 on GigabitEthernet0/0 from 10.0.0.1
*Jul 22 20:00:57.959: OSPF: Rcv hello from 192.168.2.1 area 0 from Serial0/0/1 172.16.0.1
*Jul 22 20:00:57.959: OSPF: End of hello processing
*Jul 22 20:00:59.011: OSPF: Send hello to 224.0.0.5 area 0 on Serial0/0/0 from 172.17.0.1
*Jul 22 20:01:00.963: OSPF: Send hello to 224.0.0.5 area 0 on Serial0/0/1 from 172.16.0.2
R2 #

R2 # **undebug all**
R2 # **terminal no monitor**

Enable passive interface

This command disables OSPF Hello packets from being sent on that interface.

Example - R2

R2# **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R2 (config) # **router ospf 2**
R2 (config-router) # **passive-interface Gigabitethernet 0/0**
R2 (config-router) # **end**

R2 – Verification:

After enabling above commands, again verify default behaviour of OSPF Hello packets by enabling debug commands. Now you will not able see the following line in the debug outputs.

OSPF: Send hello to 224.0.0.5 area 0 on GigabitEthernet0/0 from 10.0.0.1

This means that you have successfully disabled sending of OSPF Hello packet on selected Interface.

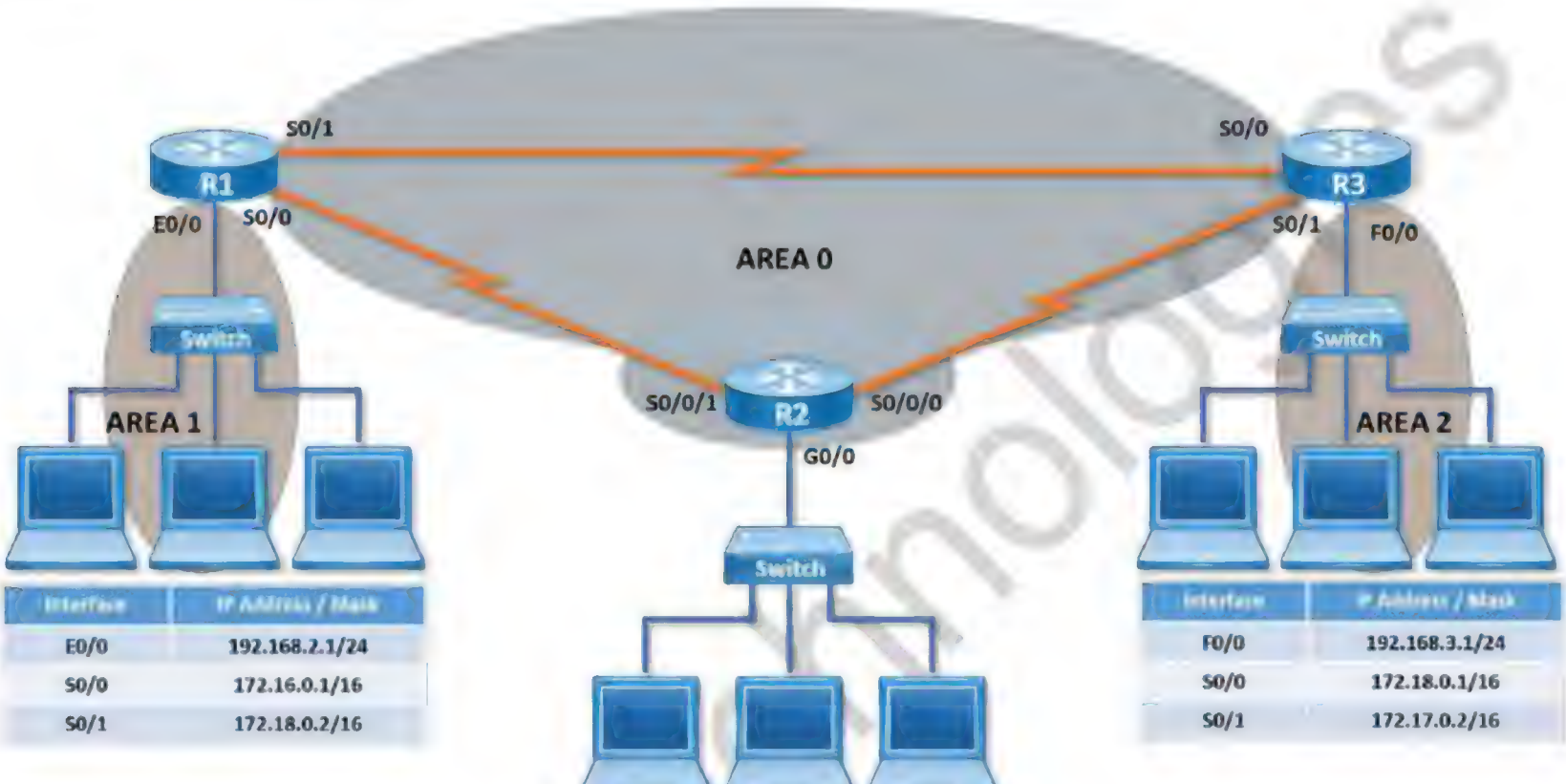
LAB 8: OSPF ROUTING - Multiple Area

OBJECTIVE:

To configure OSPF with a backbone area (area 0) and multiple areas connected to the backbone.

TOPOLOGY:

Setup Ethernet and Serial connectivity for the lab as below :



Interface	IP Address / Mask
E0/0	192.168.2.1/24
S0/0	172.16.0.1/16
S0/1	172.18.0.2/16

Interface	IP Address / Mask
F0/0	192.168.3.1/24
S0/0	172.18.0.1/16
S0/1	172.17.0.2/16

Interface	IP Address / Mask
G0/0	10.0.0.1/8
S0/0/0	172.17.0.1/16
S0/0/1	172.16.0.2/16

Pre-requisite: WAN Interface configuration to be done on the router (LAB – 3)

TASK:

- Configure OSPF Routing with backbone area and multiple connected areas.
- Verify OSPF Routing
- Verify Communication between the networks
- Verify OSPF Neighbour and Topology Table

Configure OSPF Routing with backbone area and multiple connected areas.

R1 – Configuration

R1 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R1 (config) # **ip routing**
R1 (config) # **router ospf 1**
R1 (config-router) # **network 192.168.2.0 0.0.0.255 area 1**
R1 (config-router) # **network 172.16.0.0 0.0.255.255 area 0**
R1 (config-router) # **network 172.18.0.0 0.0.255.255 area 0**
R1 (config-router) # **end**
R1 (config) #

R2 – Configuration

R2 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R2 (config) # **ip routing**
R2 (config) # **router ospf 2**
R2 (config-router) # **network 10.0.0.0 0.255.255.255 area 0**
R2 (config-router) # **network 172.16.0.0 0.0.255.255 area 0**
R2 (config-router) # **network 172.17.0.0 0.0.255.255 area 0**
R2 (config-router) # **end**
R2 (config) #

R3 – Configuration

R3 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R3 (config) # **ip routing**
R3 (config) # **router ospf 3**
R3 (config-router) # **network 192.168.3.0 0.0.0.255 area 2**
R3 (config-router) # **network 172.17.0.0 0.0.255.255 area 0**
R3 (config-router) # **network 172.18.0.0 0.0.255.255 area 0**
R3 (config-router) # **end**
R3 (config) #

Verify OSPF Routing

Once OSPF routing is enabled, IP networks learned through **OSPF** are added into the routing table.

"IA" represents **OSPF Inter Area route.**

R1 – Verification:

R1 # **show ip route**

Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
* - candidate default, U - per-user static route, o - ODR
P - periodic downloaded static route

Gateway of last resort is not set

O 172.17.0.0/16 [110/128] via 172.16.0.2, 00:00:01, Serial0/0
[110/128] via 172.18.0.1, 00:00:01, Serial0/1
C 172.16.0.0/16 is directly connected, Serial0/0
C 172.18.0.0/16 is directly connected, Serial0/1
O 10.0.0.0/8 [110/65] via 172.16.0.2, 00:00:01, Serial0/0
C 192.168.2.0/24 is directly connected, Ethernet0/0
O IA 192.168.3.0/24 [110/65] via 172.18.0.1, 00:00:01, Serial0/1
R1 #

R2 – Verification:

R2 # **show ip route**

Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2
i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
ia - IS-IS inter area, * - candidate default, U - per-user static route
o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
+ - replicated route, % - next hop override

Gateway of last resort is not set

10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C 10.0.0.0/8 is directly connected, GigabitEthernet0/0
L 10.0.0.1/32 is directly connected, GigabitEthernet0/0
172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C 172.16.0.0/16 is directly connected, Serial0/0/1
L 172.16.0.2/32 is directly connected, Serial0/0/1

```
     172.17.0.0/16 is variably subnetted, 2 subnets, 2 masks
C       172.17.0.0/16 is directly connected, Serial0/0/0
L       172.17.0.1/32 is directly connected, Serial0/0/0
O       172.18.0.0/16 [110/128] via 172.17.0.2, 00:00:51, Serial0/0/0
                      [110/128] via 172.16.0.1, 00:01:55, Serial0/0/1
O IA  192.168.2.0/24 [110/74] via 172.16.0.1, 00:01:55, Serial0/0/1
O IA  192.168.3.0/24 [110/65] via 172.17.0.2, 00:01:01, Serial0/0/0
R2 #
```

R3 – Verification:

R3 # **show ip route**

```
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

C       172.17.0.0/16 is directly connected, Serial0/1
O       172.16.0.0/16 [110/128] via 172.18.0.2, 00:01:48, Serial0/0
                      [110/128] via 172.17.0.1, 00:01:48, Serial0/1
C       172.18.0.0/16 is directly connected, Serial0/0
O       10.0.0.0/8 [110/65] via 172.17.0.1, 00:01:48, Serial0/1
O IA  192.168.2.0/24 [110/74] via 172.18.0.2, 00:01:48, Serial0/0
C       192.168.3.0/24 is directly connected, FastEthernet0/0
R3 #
```

Verify communication between the networks

Verification from a Computer in R1 Network

ping 10.0.0.10

PING 10.0.0.10 (10.0.0.10) 56(84) bytes of data.
64 bytes from 10.0.0.10: icmp_seq=1 ttl=62 time=24.0 ms
64 bytes from 10.0.0.10: icmp_seq=2 ttl=62 time=24.0 ms
64 bytes from 10.0.0.10: icmp_seq=3 ttl=62 time=24.1 ms
64 bytes from 10.0.0.10: icmp_seq=4 ttl=62 time=24.0 ms

ping 192.168.3.10

PING 192.168.3.10 (192.168.3.10) 56(84) bytes of data.
64 bytes from 192.168.3.10: icmp_seq=25 ttl=62 time=24.1 ms
64 bytes from 192.168.3.10: icmp_seq=26 ttl=62 time=24.1 ms
64 bytes from 192.168.3.10: icmp_seq=27 ttl=62 time=24.3 ms
64 bytes from 192.168.3.10: icmp_seq=28 ttl=62 time=24.2 ms
64 bytes from 192.168.3.10: icmp_seq=29 ttl=62 time=24.2 ms

Repeat the above ping verification from a computer in R2 and R3 Network.

Verify OSPF Neighbour and Database Table

R1 – Verification:

R1 # **show ip ospf neighbor**

Neighbor ID	Pri	State	Dead Time	Address	Interface
172.17.0.1	1	FULL/ -	00:00:31	172.16.0.2	Serial0/0
192.168.3.1	1	FULL/ -	00:00:34	172.18.0.1	Serial0/1

R1 #

R1 # **show ip ospf database**

OSPF Router with ID (192.168.2.1) (Process ID 1)

Router Link States (Area 0)

Link ID	ADV Router	Age	Seq#	Checksum	Link count
172.17.0.1	172.17.0.1	161	0x80000005	0x385F	5
192.168.2.1	192.168.2.1	147	0x80000005	0xA35E	4
192.168.3.1	192.168.3.1	125	0x80000004	0xF20D	4

Summary Net Link States (Area 0)

Link ID	ADV Router	Age	Seq#	Checksum
192.168.2.0	192.168.2.1	586	0x80000001	0x655
192.168.3.0	192.168.3.1	120	0x80000001	0x99C8

Router Link States (Area 1)

Link ID	ADV Router	Age	Seq#	Checksum	Link count
192.168.2.1	192.168.2.1	596	0x80000001	0x4B98	1

Summary Net Link States (Area 1)

Link ID	ADV Router	Age	Seq#	Checksum
10.0.0.0	192.168.2.1	379	0x80000001	0x7312
172.16.0.0	192.168.2.1	364	0x80000004	0x6070
172.17.0.0	192.168.2.1	145	0x80000003	0xD8B7
172.18.0.0	192.168.2.1	116	0x80000004	0x4886
192.168.3.0	192.168.2.1	121	0x80000001	0x23FF

R1 #

R2 – Verification:

R2 # **show ip ospf neighbor**

Neighbor ID	Pri	State	Dead Time	Address	Interface
192.168.3.1	0	FULL/ -	00:00:39	172.17.0.2	Serial0/0/0
192.168.2.1	0	FULL/ -	00:00:32	172.16.0.1	Serial0/0/1

R2 #

R2 # **show ip ospf database**

OSPF Router with ID (172.17.0.1) (Process ID 2)

Router Link States (Area 0)

Link ID	ADV Router	Age	Seq#	Checksum	Link count
172.17.0.1	172.17.0.1	56	0x80000005	0x385F	5
192.168.2.1	192.168.2.1	48	0x80000005	0xD3A9	5
192.168.3.1	192.168.3.1	46	0x80000004	0x87B	5

Summary Net Link States (Area 0)

Link ID	ADV Router	Age	Seq#	Checksum
192.168.2.0	192.168.2.1	1179	0x80000001	0x000655
192.168.3.0	192.168.3.1	713	0x80000001	0x0099C8

R2 #

R3 – Verification:

R3 # **show ip ospf neighbor**

Neighbor ID	Pri	State	Dead Time	Address	Interface
192.168.2.1	0	FULL/ -	00:00:38	172.18.0.2	Serial0/0
172.17.0.1	0	FULL/ -	00:00:34	172.17.0.1	Serial0/1

R3 #

R3 # **show ip ospf database**

OSPF Router with ID (192.168.3.1) (Process ID 3)

Router Link States (Area 0)

Link ID	ADV Router	Age	Seq#	Checksum	Link count
172.17.0.1	172.17.0.1	488	0x80000006	0x00D5C0	5
192.168.2.1	192.168.2.1	1465	0x80000005	0x00A35E	4
192.168.3.1	192.168.3.1	1441	0x80000004	0x00F20D	4

Summary Net Link States (Area 0)

Link ID	ADV Router	Age	Seq#	Checksum
192.168.2.0	192.168.2.1	1904	0x80000001	0x000655
192.168.3.0	192.168.3.1	1437	0x80000001	0x0099C8

Router Link States (Area 2)

Link ID	ADV Router	Age	Seq#	Checksum	Link count
192.168.3.1	192.168.3.1	1441	0x80000001	0x009F4A	1

Summary Net Link States (Area 2)

Link ID	ADV Router	Age	Seq#	Checksum
10.0.0.0	192.168.3.1	1442	0x80000001	0x006C18
172.16.0.0	192.168.3.1	1442	0x80000001	0x00E1B0
172.17.0.0	192.168.3.1	1442	0x80000001	0x00537E
172.18.0.0	192.168.3.1	1442	0x80000001	0x004789
192.168.2.0	192.168.3.1	1443	0x80000001	0x008198

R3#

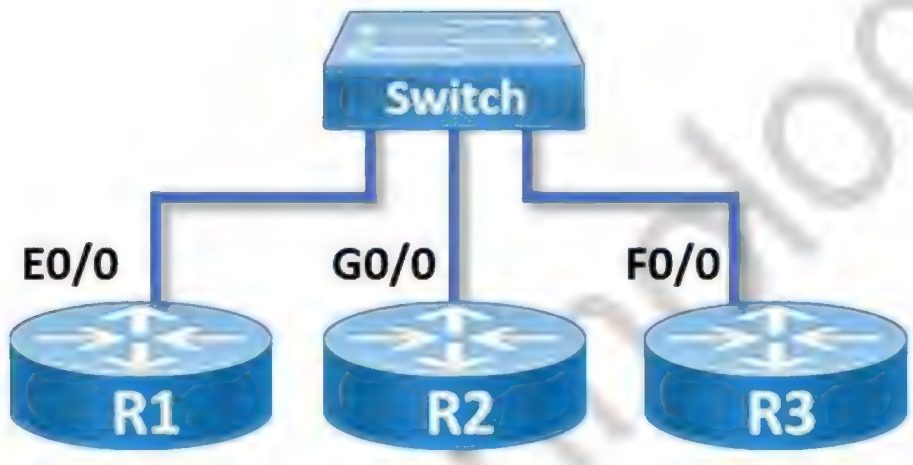
LAB 9: OSPF ROUTING – DR (Designated Router) and BDR (Backup Designated Router)

OBJECTIVE:

To understand how a DR and BDR are elected when OPSF is configured on routers connected via Ethernet

TOPOLOGY:

Setup the routers for the lab as below:



TASK:

- Configure OSPF Routing
- Verify OSPF Neighbour relationship (DR / BDR / DROTHER)
- Understand OSPF DR and BDR Election
- Change OSPF Priority to force a particular router to become the DR

Configure OSPF Routing

R1 – Configuration

R1 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R1 (config) # **ip routing**
R1 (config) # **router ospf 1**
R1 (config-router) # **network 10.0.0.0 0.255.255.255 area 0**
R1 (config-router) # **end**
R1 (config) #

R2 – Configuration

R2 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R2 (config) # **ip routing**
R2 (config) # **router ospf 2**
R2 (config-router) # **network 10.0.0.0 0.255.255.255 area 0**
R2 (config-router) # **end**
R2 (config) #

R3 – Configuration

R3 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R3 (config) # **ip routing**
R3 (config) # **router ospf 3**
R3 (config-router) # **network 10.0.0.0 0.255.255.255 area 0**
R3 (config-router) # **end**
R3 (config) #

Verify OSPF Neighbour relationship (DR / BDR / DROTHER)

By default, when OSPF is configured on a router on Ethernet, the first router becomes the DR. The router which is configured next becomes the BDR.

R1 – Verification:

R1 # **show ip ospf neighbor**

Neighbor ID	Pri	State	Dead Time	Address	Interface
10.0.0.3	1	FULL/DROTHER	00:00:36	10.0.0.3	Ethernet0/0
10.0.0.2	1	FULL/BDR	00:00:38	10.0.0.2	Ethernet0/0

R1 #

R2 – Verification:

R2 # **show ip ospf neighbor**

Neighbor ID	Pri	State	Dead Time	Address	Interface
10.0.0.1	1	FULL/DR	00:00:31	10.0.0.1	GigabitEthernet0/0
10.0.0.3	1	FULL/DROTHER	00:00:34	10.0.0.3	GigabitEthernet0/0

R2 #

R3 – Verification:

R3 # **show ip ospf neighbor**

Neighbor ID	Pri	State	Dead Time	Address	Interface
10.0.0.1	1	FULL/DR	00:00:37	10.0.0.1	FastEthernet0/0
10.0.0.2	1	FULL/BDR	00:00:32	10.0.0.2	FastEthernet0/0

R3 #

Understand OSPF DR and BDR Election

If OSPF is enabled on all the routers at the same time, by default, the router with the Highest Router ID will become DR and the one with the second Highest Router ID will become BDR.

Clear OSPF process by giving the following command on all routers for the new election of DR and BDR.

Router # **clear ip ospf process**
Reset ALL OSPF processes? [no]: **yes**
Router #

R1 – Verification:

R1 # **show ip ospf neighbor**

Neighbor ID	Pri	State	Dead Time	Address	Interface
10.0.0.3	1	FULL/DR	00:00:36	10.0.0.3	Ethernet0/0
10.0.0.2	1	FULL/BDR	00:00:38	10.0.0.2	Ethernet0/0

R1 #

R2 – Verification:

R2 # **show ip ospf neighbor**

Neighbor ID	Pri	State	Dead Time	Address	Interface
10.0.0.1	1	FULL/DROTHER	00:00:31	10.0.0.1	GigabitEthernet0/0
10.0.0.3	1	FULL/DR	00:00:34	10.0.0.3	GigabitEthernet0/0

R2 #

R3 – Verification:

R3 # **show ip ospf neighbor**

Neighbor ID	Pri	State	Dead Time	Address	Interface
10.0.0.1	1	FULL/DROTHER	00:00:37	10.0.0.1	FastEthernet0/0
10.0.0.2	1	FULL/BDR	00:00:32	10.0.0.2	FastEthernet0/0

R3 #

Change OSPF Priority to force a particular router to become the DR

By changing the OSPF priority, we can force a router to become the DR. The router with the highest priority becomes the DR , the router with the second highest priority becomes the BDR.

R1 – Configuration

R1 (config) # **interface Ethernet 0/0**
R1 (config-if) # **ip ospf priority 150**
R1 (config-if) #**^Z**
R1 #

R2 – Configuration

R2 (config) # **interface Gigabitethernet 0/0**
R2 (config-if) # **ip ospf priority 200**
R2 (config-if) #**^Z**
R2 #

R3 – Configuration

R3 (config) # **interface Fastethernet 0/0**
R3 (config-if) # **ip ospf priority 100**
R3 (config-if) #**^Z**

R3 #

Clear OSPF process by giving the following command on all routers for the new election of DR and BDR.

Router # **clear ip ospf process**
Reset ALL OSPF processes? [no]: **yes**
Router #

R1 – Verification:

R1 # **show ip ospf neighbor**

Neighbor ID	Pri	State	Dead Time	Address	Interface
10.0.0.3	100	FULL/DROTHER	00:00:36	10.0.0.3	Ethernet0/0
10.0.0.2	200	FULL/DR	00:00:38	10.0.0.2	Ethernet0/0

R1 #

R1 # **show ip ospf interface ethernet 0/0**
Ethernet0/0 is up, line protocol is up
Internet Address 10.0.0.1/8, Area 0
Process ID 1, Router ID 10.0.0.1, Network Type BROADCAST, Cost: 10
Transmit Delay is 1 sec, State BDR, Priority 150
Designated Router (ID) 10.0.0.2, Interface address 10.0.0.2
Backup Designated router (ID) 10.0.0.1, Interface address 10.0.0.1
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
Hello due in 00:00:01
Index 1/1, flood queue length 0
Next 0x0(0)/0x0(0)
Last flood scan length is 0, maximum is 2
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 2, Adjacent neighbor count is 2
Adjacent with neighbor 10.0.0.3
Adjacent with neighbor 10.0.0.2 (Designated Router)
Suppress hello for 0 neighbor(s)
R1#

R2 – Verification:

R2 # **show ip ospf neighbor**

Neighbor ID	Pri	State	Dead Time	Address	Interface
10.0.0.1	150	FULL/BDR	00:00:31	10.0.0.1	GigabitEthernet0/0
10.0.0.3	100	FULL/DROTHER	00:00:34	10.0.0.3	GigabitEthernet0/0

R2 #

R2 # **show ip ospf interface gigabitethernet 0/0**
GigabitEthernet0/0 is up, line protocol is up
  Internet Address 10.0.0.2/8, Area 0
Process ID 2, Router ID 10.0.0.2, Network Type BROADCAST, Cost: 1
  Topology-MTID Cost Disabled Shutdown Topology Name
      0   1   no   no   Base
Transmit Delay is 1 sec, State DR, Priority 200
Designated Router (ID) 10.0.0.2, Interface address 10.0.0.2
Backup Designated router (ID) 10.0.0.1, Interface address 10.0.0.1
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:02
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 3
  Last flood scan time is 0 msec, maximum is 4 msec
  Neighbor Count is 2, Adjacent neighbor count is 2
Adjacent with neighbor 10.0.0.1 (Backup Designated Router)
Adjacent with neighbor 10.0.0.3
  Suppress hello for 0 neighbor(s)
R2#

R3 – Verification:

R3 # **show ip ospf neighbor**

Neighbor ID	Pri	State	Dead Time	Address	Interface
10.0.0.1	1	FULL/BDR	00:00:37	10.0.0.1	FastEthernet0/0
10.0.0.2	1	FULL/DR	00:00:32	10.0.0.2	FastEthernet0/0

R3 #

R3 # **show ip ospf interface fastethernet 0/0**
FastEthernet0/0 is up, line protocol is up
  Internet Address 10.0.0.3/8, Area 0
Process ID 1, Router ID 10.0.0.3, Network Type BROADCAST, Cost: 1
Transmit Delay is 1 sec, State DROTHER, Priority 100
Designated Router (ID) 10.0.0.2, Interface address 10.0.0.2
Backup Designated router (ID) 10.0.0.1, Interface address 10.0.0.1
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:09
  Supports Link-local Signaling (LLS)
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 0, maximum is 3
  Last flood scan time is 0 msec, maximum is 4 msec
  Neighbor Count is 2, Adjacent neighbor count is 2
Adjacent with neighbor 10.0.0.1 (Backup Designated Router)
    Adjacent with neighbor 10.0.0.2 (Designated Router)
  Suppress hello for 0 neighbor(s)
R3#

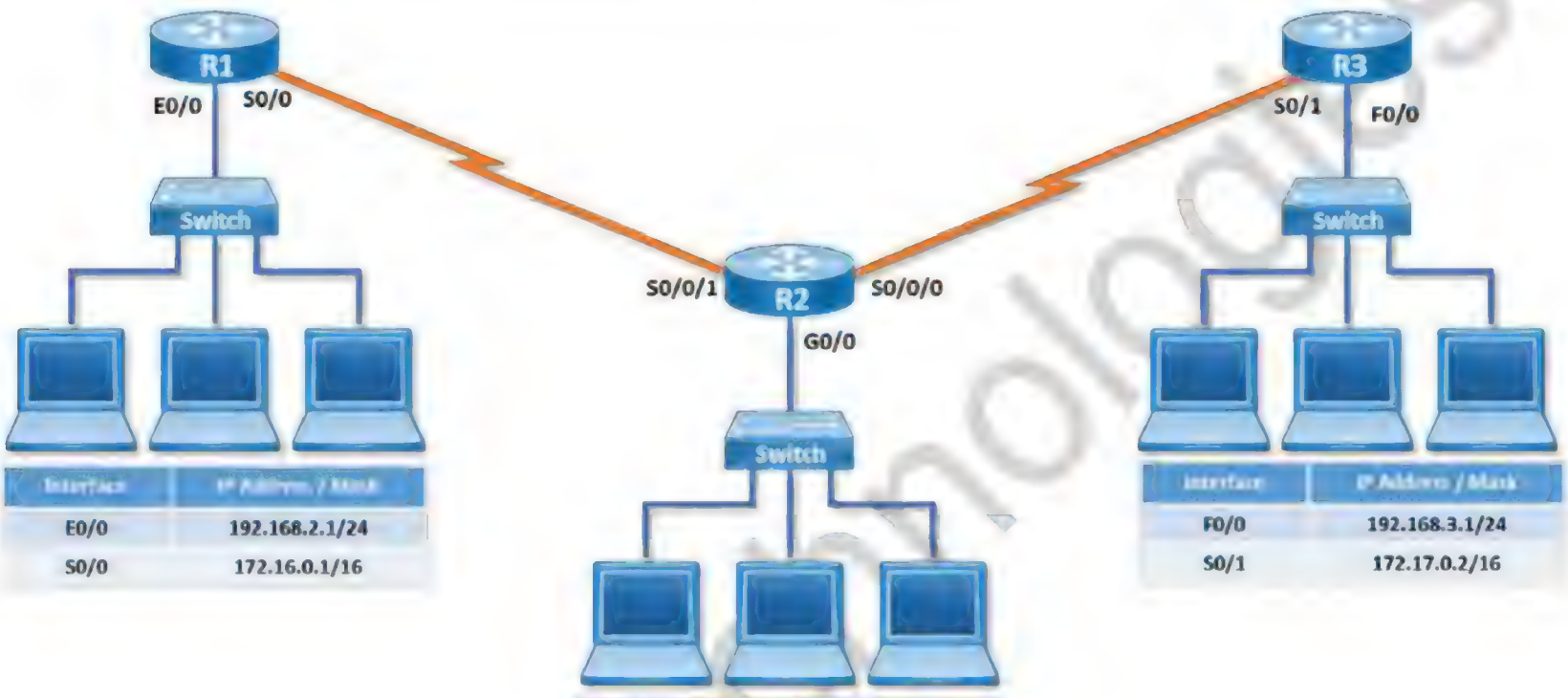
LAB 10: STANDARD ACCESS CONTROL LIST

OBJECTIVE:

To configure and implement access-list on R2 such that 192.168.2.10 should not communicate with 10.0.0.0 network

TOPOLOGY:

Configure Ethernet and Serial IP addresses for the lab as below :



Interface	IP Address / Mask
E0/0	192.168.2.1/24
S0/0	172.16.0.1/16

Interface	IP Address / Mask
G0/0	10.0.0.1/8
S0/0/0	172.17.0.1/16
S0/0/1	172.16.0.2/16

Interface	IP Address / Mask
F0/0	192.168.3.1/24
S0/1	172.17.0.2/16

Pre-requisite: WAN Interface and Routing configuration to be done on the router (LAB – 3 and 4)

TASK:

- Verify communication between computers / networks before configuring the access list
- Configure and implement Standard ACL
- Verify blocked communication between computers / networks specified in ACL

Verify communication between computers / networks before configuring the access list

From 192.168.2.10 Computer in R1 Network

ping 10.0.0.10

PING 10.0.0.10 (10.0.0.10) 56(84) bytes of data.
64 bytes from 10.0.0.10: icmp_seq=1 ttl=62 time=24.0 ms
64 bytes from 10.0.0.10: icmp_seq=2 ttl=62 time=24.0 ms
64 bytes from 10.0.0.10: icmp_seq=3 ttl=62 time=24.1 ms
64 bytes from 10.0.0.10: icmp_seq=4 ttl=62 time=24.0 ms

ping 192.168.3.10

PING 192.168.3.10 (192.168.3.10) 56(84) bytes of data.
64 bytes from 192.168.3.10: icmp_seq=25 ttl=62 time=24.1 ms
64 bytes from 192.168.3.10: icmp_seq=26 ttl=62 time=24.1 ms
64 bytes from 192.168.3.10: icmp_seq=27 ttl=62 time=24.3 ms
64 bytes from 192.168.3.10: icmp_seq=28 ttl=62 time=24.2 ms
64 bytes from 192.168.3.10: icmp_seq=29 ttl=62 time=24.2 ms

From 192.168.2.20 computer in R1 Network

ping 10.0.0.10

PING 10.0.0.10 (10.0.0.10) 56(84) bytes of data.
64 bytes from 10.0.0.10: icmp_seq=1 ttl=62 time=24.0 ms
64 bytes from 10.0.0.10: icmp_seq=2 ttl=62 time=24.0 ms
64 bytes from 10.0.0.10: icmp_seq=3 ttl=62 time=24.1 ms
64 bytes from 10.0.0.10: icmp_seq=4 ttl=62 time=24.0 ms

ping 192.168.3.10

PING 192.168.3.10 (192.168.3.10) 56(84) bytes of data.
64 bytes from 192.168.3.10: icmp_seq=25 ttl=62 time=24.1 ms
64 bytes from 192.168.3.10: icmp_seq=26 ttl=62 time=24.1 ms
64 bytes from 192.168.3.10: icmp_seq=27 ttl=62 time=24.3 ms
64 bytes from 192.168.3.10: icmp_seq=28 ttl=62 time=24.2 ms
64 bytes from 192.168.3.10: icmp_seq=29 ttl=62 time=24.2 ms

Configure and Implement Standard ACL

R2 – Configuration

R2 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R2 (config) # **access-list 1 deny 192.168.2.10 0.0.0.0**
R2 (config) # **access-list 1 permit any**

R2 (config) # **interface gigabitEthernet 0/0**
R2 (config-if) # **ip access-group 1 out**
R2 (config-if) # **exit**

R2 – Verification:

R2 # **show ip access-lists**
Standard IP access list 1
  10 deny 192.168.2.10
  20 permit any
R2#

R2 # **show ip interface gigabitEthernet 0/0**
GigabitEthernet0/0 is up, line protocol is up
 Internet address is 10.0.0.1/8
 Broadcast address is 255.255.255.255
 Address determined by setup command
 MTU is 1500 bytes
 Helper address is not set
 Directed broadcast forwarding is disabled
Outgoing access list is 1
 Inbound access list is not set
 Proxy ARP is enabled
 Local Proxy ARP is disabled
 Security level is default
 Split horizon is enabled
 !
<output omitted>
 !
 WCCP Redirect outbound is disabled
 WCCP Redirect inbound is disabled
 WCCP Redirect exclude is disabled
R2#

Verify blocked communication between computers / networks specified in ACL

From 192.168.2.10 computer in R1 Network

ping 10.0.0.10

PING 10.0.0.10 (10.0.0.10) 56(84) bytes of data.
From 10.0.0.1 icmp_seq=1 Packet filtered
From 10.0.0.1 icmp_seq=2 Packet filtered
From 10.0.0.1 icmp_seq=3 Packet filtered
From 10.0.0.1 icmp_seq=4 Packet filtered
From 10.0.0.1 icmp_seq=5 Packet filtered

ping 192.168.3.10

PING 192.168.3.10 (192.168.3.10) 56(84) bytes of data.
64 bytes from 192.168.3.10: icmp_seq=25 ttl=62 time=24.1 ms
64 bytes from 192.168.3.10: icmp_seq=26 ttl=62 time=24.1 ms
64 bytes from 192.168.3.10: icmp_seq=27 ttl=62 time=24.3 ms
64 bytes from 192.168.3.10: icmp_seq=28 ttl=62 time=24.2 ms
64 bytes from 192.168.3.10: icmp_seq=29 ttl=62 time=24.2 ms

From 192.168.2.20 computer in R1 Network

ping 10.0.0.10

PING 10.0.0.10 (10.0.0.10) 56(84) bytes of data.
64 bytes from 10.0.0.10: icmp_seq=1 ttl=62 time=24.0 ms
64 bytes from 10.0.0.10: icmp_seq=2 ttl=62 time=24.0 ms
64 bytes from 10.0.0.10: icmp_seq=3 ttl=62 time=24.1 ms
64 bytes from 10.0.0.10: icmp_seq=4 ttl=62 time=24.0 ms

ping 192.168.3.10

PING 192.168.3.10 (192.168.3.10) 56(84) bytes of data.
64 bytes from 192.168.3.10: icmp_seq=25 ttl=62 time=24.1 ms
64 bytes from 192.168.3.10: icmp_seq=26 ttl=62 time=24.1 ms
64 bytes from 192.168.3.10: icmp_seq=27 ttl=62 time=24.3 ms
64 bytes from 192.168.3.10: icmp_seq=28 ttl=62 time=24.2 ms
64 bytes from 192.168.3.10: icmp_seq=29 ttl=62 time=24.2 ms

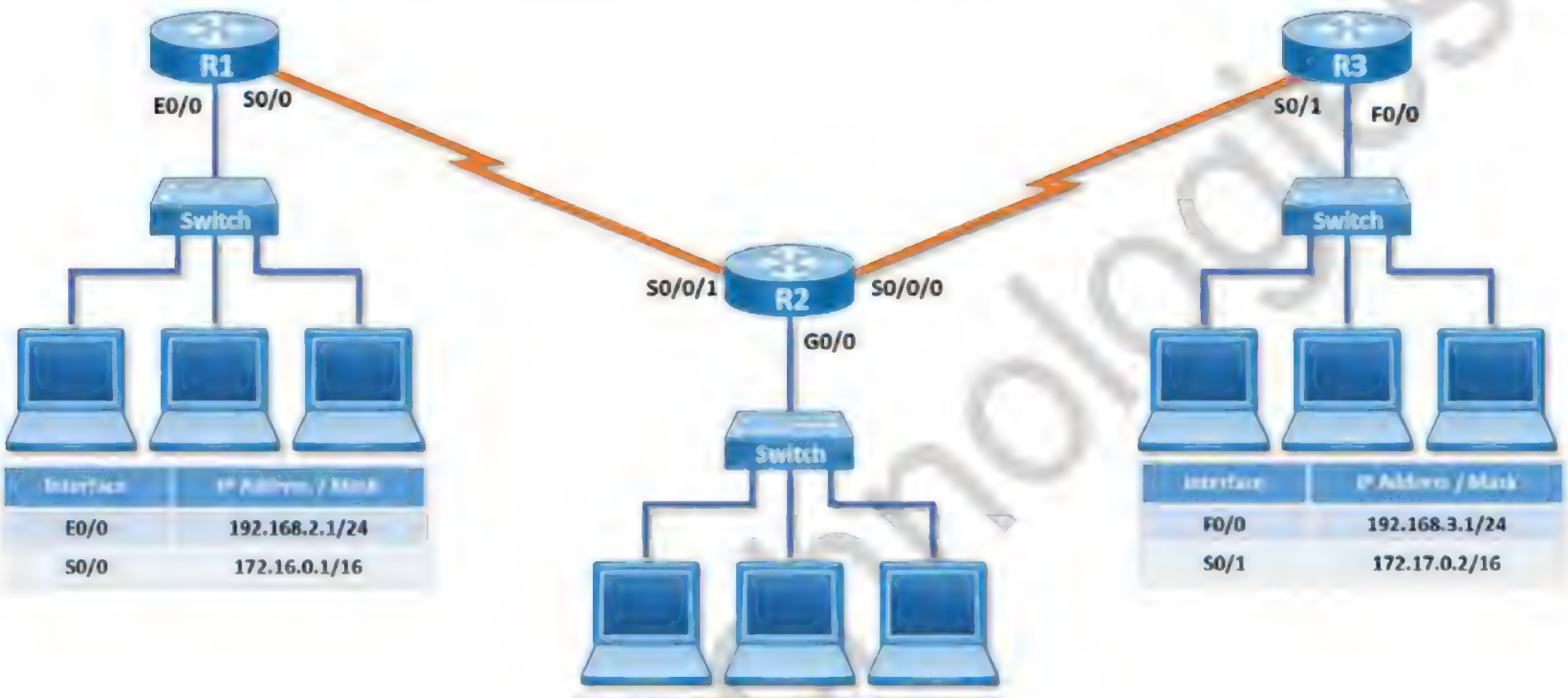
LAB 11: EXTENDED ACCESS CONTROL LIST

OBJECTIVE:

Deny R2 Network (i.e. 10.0.0.0/8) from accessing HTTP server (i.e. 192.168.3.10) in R3 Network and also deny ping to R1 Network (i.e. 192.168.2.0/24)

TOPOLOGY:

Configure Ethernet and Serial IP addresses for the lab as below :



Interface	IP Address / Mask
E0/0	192.168.2.1/24
S0/0	172.16.0.1/16

Interface	IP Address / Mask
G0/0	10.0.0.1/8
S0/0/0	172.17.0.1/16
S0/0/1	172.16.0.2/16

Interface	IP Address / Mask
F0/0	192.168.3.1/24
S0/1	172.17.0.2/16

Pre-requisite: WAN Interface and Routing configuration to be done on the router (LAB – 3 and 4)

TASK:

- Verify services and communication between computers / networks before configuring the extended access list.
- Configure and implement Extended ACL
- Verify blocked services and communication between computers / networks specified in ACL

Verify services and communication between computers / networks before configuring the Extended Access List

From 10.0.0.10 Computer in R2 Network

ping 192.168.2.10

PING 192.168.2.10 (192.168.2.10) 56(84) bytes of data.
64 bytes from 192.168.2.10: icmp_seq=1 ttl=62 time=24.2 ms
64 bytes from 192.168.2.10: icmp_seq=2 ttl=62 time=24.1 ms
64 bytes from 192.168.2.10: icmp_seq=3 ttl=62 time=24.1 ms
64 bytes from 192.168.2.10: icmp_seq=4 ttl=62 time=24.1 ms
64 bytes from 192.168.2.10: icmp_seq=5 ttl=62 time=24.1 ms

ping 192.168.3.10

PING 192.168.3.10 (192.168.3.10) 56(84) bytes of data.
64 bytes from 192.168.3.10: icmp_seq=25 ttl=62 time=24.1 ms
64 bytes from 192.168.3.10: icmp_seq=26 ttl=62 time=24.1 ms
64 bytes from 192.168.3.10: icmp_seq=27 ttl=62 time=24.3 ms
64 bytes from 192.168.3.10: icmp_seq=28 ttl=62 time=24.2 ms
64 bytes from 192.168.3.10: icmp_seq=29 ttl=62 time=24.2 ms

Try to access HTTP Server via browser (i.e. http://192.168.3.10)

You should able to see Test web page, indicates http service is allowed.

Configure and Implement Extended ACL

R2 – Configuration

R2 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R2 (config) # **access-list 101 deny tcp 10.0.0.0 0.255.255.255 192.168.3.10 0.0.0.0 eq www**
R2 (config) # **access-list 101 deny icmp 10.0.0.0 0.255.255.255 192.168.2.0 0.0.0.255 echo**
R2 (config) # **access-list 101 permit ip any any**

R2 (config) # **interface gigabitEthernet 0/0**
R2 (config-if) # **ip access-group 101 in**
R2 (config-if) # **exit**

R2 – Verification:

R2 # **show ip access-lists**
Extended IP access list 101
10 deny tcp 10.0.0.0 0.255.255.255 host 192.168.3.10 eq www (5 matches)
20 deny icmp 10.0.0.0 0.255.255.255 192.168.2.0 0.0.0.255 echo (10 matches)
30 permit ip any any (87 matches)
R2#

R2 # **show ip interface gigabitEthernet 0/0**
GigabitEthernet0/0 is up, line protocol is up
Internet address is 10.0.0.1/8
Broadcast address is 255.255.255.255
Address determined by setup command
MTU is 1500 bytes
Helper address is not set
Directed broadcast forwarding is disabled
Multicast reserved groups joined: 224.0.0.5 224.0.0.6
Outgoing access list is not set
Inbound access list is 101
Proxy ARP is enabled
Local Proxy ARP is disabled
Security level is default
Split horizon is enabled
!
<output omitted>
!
WCCP Redirect outbound is disabled
WCCP Redirect inbound is disabled
WCCP Redirect exclude is disabled
R2#

Verify blocked services and communication between computers / networks specified in ACL

From 10.0.0.10 Computer in R2 Network

ping 192.168.2.10

PING 192.168.2.10 (192.168.2.10) 56(84) bytes of data.
From 10.0.0.1 icmp_seq=1 Packet filtered
From 10.0.0.1 icmp_seq=2 Packet filtered
From 10.0.0.1 icmp_seq=3 Packet filtered
From 10.0.0.1 icmp_seq=4 Packet filtered
From 10.0.0.1 icmp_seq=5 Packet filtered

ping 192.168.3.10

PING 192.168.3.10 (192.168.3.10) 56(84) bytes of data.
64 bytes from 192.168.3.10: icmp_seq=25 ttl=62 time=24.1 ms
64 bytes from 192.168.3.10: icmp_seq=26 ttl=62 time=24.1 ms
64 bytes from 192.168.3.10: icmp_seq=27 ttl=62 time=24.3 ms
64 bytes from 192.168.3.10: icmp_seq=28 ttl=62 time=24.2 ms
64 bytes from 192.168.3.10: icmp_seq=29 ttl=62 time=24.2 ms

Try to access HTTP Server via browser (i.e. http://192.168.3.10)

You should not able to see Test web page, indicates http service is blocked.

LAB 12: INITIAL CONFIGURATION OF SWITCH

OBJECTIVE:

To get familiar with Cisco Switch IOS modes and configure a New Switch with basic configuration i.e. assigning management IP address to the switch and configure passwords etc.

TOPOLOGY:

Setup console and ethernet connectivity for the lab as below :

TASK:

- Establish console connectivity
- Access switch via console with an emulation software
- Get familiar with Cisco Switch IOS Modes and Show commands
- Configure Hostname and VLAN 1 Interface IP address
- Configure Connectivity Passwords
- Configure Privilege Mode / Enable Password
- Save configuration on the switch
- Access the Switch via Telnet

Establish console connectivity

Establish console connectivity by connecting switch console port to PC Com Port with console cable.

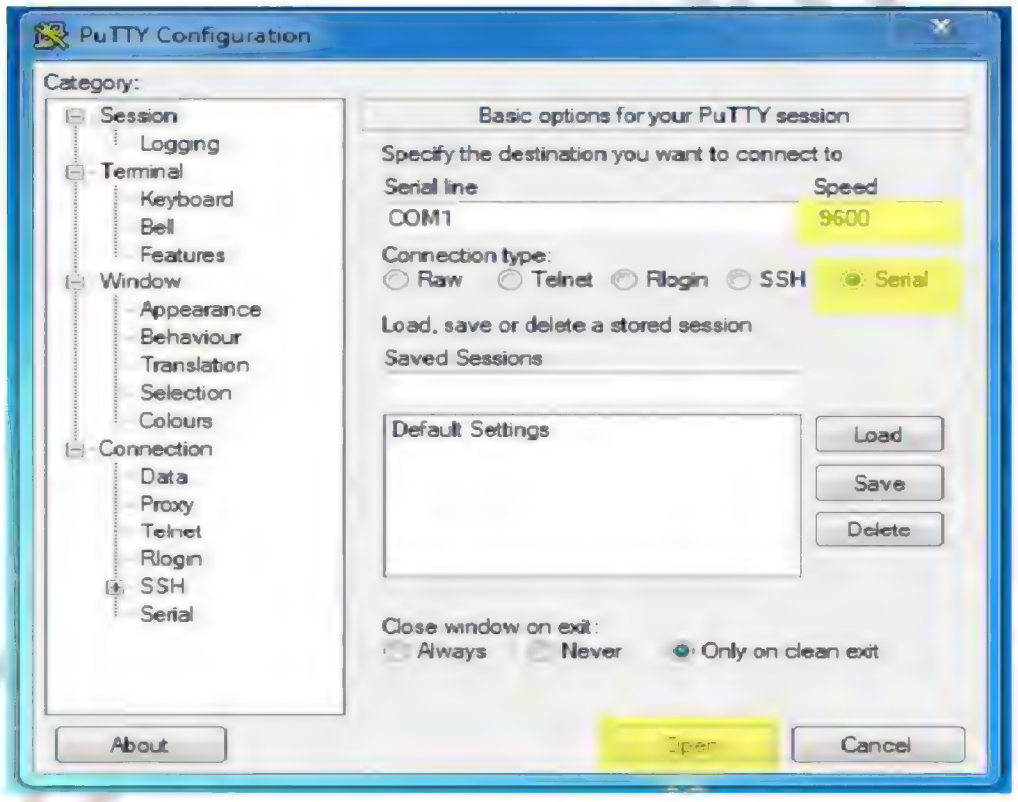
Access switch via console with an emulation software

Configure the following parameters in emulation software for accessing switch via console port.

Parameters	Console Port Settings
Baud	9600
Data bits	8
Parity	None
Stop bits	1

Accessing switch via console from Microsoft Windows Computer

- Start a terminal emulator application, such as **PUTTY.exe**
- Select **Serial** option and set speed to **9600.**
- Click **Open**



- Once emulation software is ready, **Power-ON** the switch.

Accessing switch via console from Linux Computer

- From the terminal enter the below command
  # minicom

- Once emulation software is ready, **Power-ON** the Switch.

Getting familiar with Cisco Switch IOS Modes and show commands

After the switch boots-up completely, (on a new Cisco Switch) it enters user mode as below:

```
Switch>
```

To navigate into Privilege mode/Executive Mode from User Mode

Switch >**enable**
Switch #

To view switch IOS and hardware information

Switch # **show version**

```
Cisco Internetwork Operating System Software
IOS (tm) C2950 Software (C2950-I6Q4L2-M), Version 12.1(22)EA6, RELEASE SOFTWARE (fc1)
Copyright (c) 1986-2005 by cisco Systems, Inc.
Compiled Fri 21-Oct-05 01:59 by yenanh
Image text-base: 0x80010000, data-base: 0x80568000

ROM: Bootstrap program is C2950 boot loader

Switch uptime is 4 minutes
System returned to ROM by power-on
System image file is "flash:/c2950-i6q4l2-mz.121-22.EA6.bin"

cisco WS-C2950-24 (RC32300) processor (revision G0) with 21013K bytes of memory.
Processor board ID FOC0638Z0TB
Last reset from system-reset
Running Standard Image
24 FastEthernet/IEEE 802.3 interface(s)

32K bytes of flash-simulated non-volatile configuration memory.
Base ethernet MAC Address: 00:0A:F4:C5:94:C0
Motherboard assembly number: 73-5781-11
Power supply part number: 34-0965-01
Motherboard serial number: FOC06380AZK
Power supply serial number: DAB06347236
Model revision number: G0
Motherboard revision number: A0
Model number: WS-C2950-24
System serial number: FOC0638Z0TB
Configuration register is 0xF
```

To view switch flash Information

Switch # **show flash**

```
Directory of flash:/
  1  -rwx    3110758  Mar 01 1993 08:30:59 +00:00  c2950-i6q4l2-mz.121-22.EA6.bin
  2  -rwx        564  Mar 01 1993 00:00:28 +00:00  vlan.dat
```

```
7741440 bytes total (4628480 bytes free)
Switch #
```

To view switch current configuration (RAM)

Switch # **show running-config**

```
Building configuration...

Current configuration : 1071 bytes
!
version 12.1
no service pad
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname Switch
!
spanning-tree mode pvst
no spanning-tree optimize bpdu transmission
spanning-tree extend system-id
!
interface FastEthernet0/1
!
interface FastEthernet0/2
!
<output omitted>
!
interface FastEthernet0/23
!
interface FastEthernet0/24
!
interface Vlan1
 no ip address
 no ip route-cache
 shutdown
!
ip http server
!
line con 0
line vty 5 15
!
end
Switch #
```

To view switch startup configuration (NVRAM)

Switch # **show startup-config**

```
startup-config is not present
```

To view detailed interface information (i.e. Vlan, interface status, etc.)

Switch # **show interface status**

Port	Name	Status	Vlan	Duplex	Speed	Type
Fa0/1		connected	1	a-full	a-100	10/100BaseTX
Fa0/2		connected	1	a-full	a-100	10/100BaseTX
Fa0/3		connected	1	a-full	a-100	10/100BaseTX
Fa0/4		connected	1	a-full	a-100	10/100BaseTX
Fa0/5		connected	1	a-full	a-100	10/100BaseTX
Fa0/6		notconnect	1	auto	auto	10/100BaseTX
Fa0/7		notconnect	1	auto	auto	10/100BaseTX
Fa0/8		notconnect	1	auto	auto	10/100BaseTX
Fa0/9		notconnect	1	auto	auto	10/100BaseTX
Fa0/10		connected	1	a-half	a-10	10/100BaseTX
Fa0/11		connected	1	a-half	a-10	10/100BaseTX
Fa0/12		connected	1	a-half	a-10	10/100BaseTX
Fa0/13		connected	1	a-half	a-10	10/100BaseTX
Fa0/14		notconnect	1	auto	auto	10/100BaseTX
Fa0/15		notconnect	1	auto	auto	10/100BaseTX
Fa0/16		notconnect	1	auto	auto	10/100BaseTX
Fa0/17		notconnect	1	auto	auto	10/100BaseTX
Fa0/18		notconnect	1	auto	auto	10/100BaseTX
Fa0/19		notconnect	1	auto	auto	10/100BaseTX
Fa0/20		notconnect	1	auto	auto	10/100BaseTX
Fa0/21		notconnect	1	auto	auto	10/100BaseTX
Fa0/22		notconnect	1	auto	auto	10/100BaseTX
Fa0/23		notconnect	1	auto	auto	10/100BaseTX
Fa0/24		notconnect	1	auto	auto	10/100BaseTX

Switch #

To view Mac Address Table

Switch # **show mac-address-table**

Mac Address Table

Vlan	Mac Address	Type	Ports
All	000a.f4c5.94c0	STATIC	CPU
All	0100.0ccc.cccc	STATIC	CPU
All	0100.0ccc.cccd	STATIC	CPU
All	0100.0cdd.dddd	STATIC	CPU
1	0002.4b60.d100	DYNAMIC	Fa0/13
1	0002.fd73.7f20	DYNAMIC	Fa0/11
1	0010.7bb3.6f20	DYNAMIC	Fa0/12
1	001c.c012.4f54	DYNAMIC	Fa0/4
1	0030.9476.f160	DYNAMIC	Fa0/10

Total Mac Addresses for this criterion: 5

Switch #

Configure Hostname and VLAN 1 Interface IP address

To change the Host Name of Switch

Switch # **configure terminal**
Switch (config) # **hostname SW1**
SW1 (config) #

To configure IP address on Interface VLAN 1

SW1 (config) # **interface vlan 1**
SW1 (config-if) # **ip address 192.168.20.50 255.255.255.0**
SW1 (config-if) # **no shutdown**
SW1 (config-if) #**exit**

Configure Connectivity Passwords

To configure telnet password

SW1 (config) # **line vty 0 15**
SW1 (config-line) # **password zoom**
SW1 (config-line) #**login**
SW1 (config-line) #**exit**

To configure console password

SW1 (config) # **line console 0**
SW1 (config-line) # **password zoom**
SW1 (config-line) #**login**
SW1 (config-line) # **exit**

Configure Privilege Mode / Enable Password

Configure privilege password

SW1 (config) #**enable password ccna**
SW1 (config) #**enable secret zoom**

Save configuration on the switch

To save configuration on switch

SW1 # **copy running-config startup-config**

```
Destination filename [startup-config]?
Building configuration...

[OK]
SW1 #
```

To view switch startup configuration (NVRAM)

SW1 # **show startup-config**

```
Building configuration...
Current configuration : 1230 bytes
!
version 12.1
no service pad
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname SW1
!
enable secret 5 $1$R2we$Mk0jdo9UpDL1T7kqcKHhk1
enable password ccna
!
ip subnet-zero
!
spanning-tree mode pvst
no spanning-tree optimize bpdu transmission
spanning-tree extend system-id
!
interface FastEthernet0/1
!
interface FastEthernet0/2
!
!
<output omitted>
!
interface FastEthernet0/23
!
interface FastEthernet0/24
!
interface Vlan1
 ip address 192.168.20.50 255.255.255.0
 no ip route-cache
!
```

```
ip http server
!
line con 0
 password zoom
 login
line vty 0 4
 password zoom
 login
line vty 5 15
 password zoom
 login
!
!
end
```

Access the Switch via Telnet

- Access switch via telnet by giving the following command on a Windows or Linux computer.

  telnet 192.168.20.50

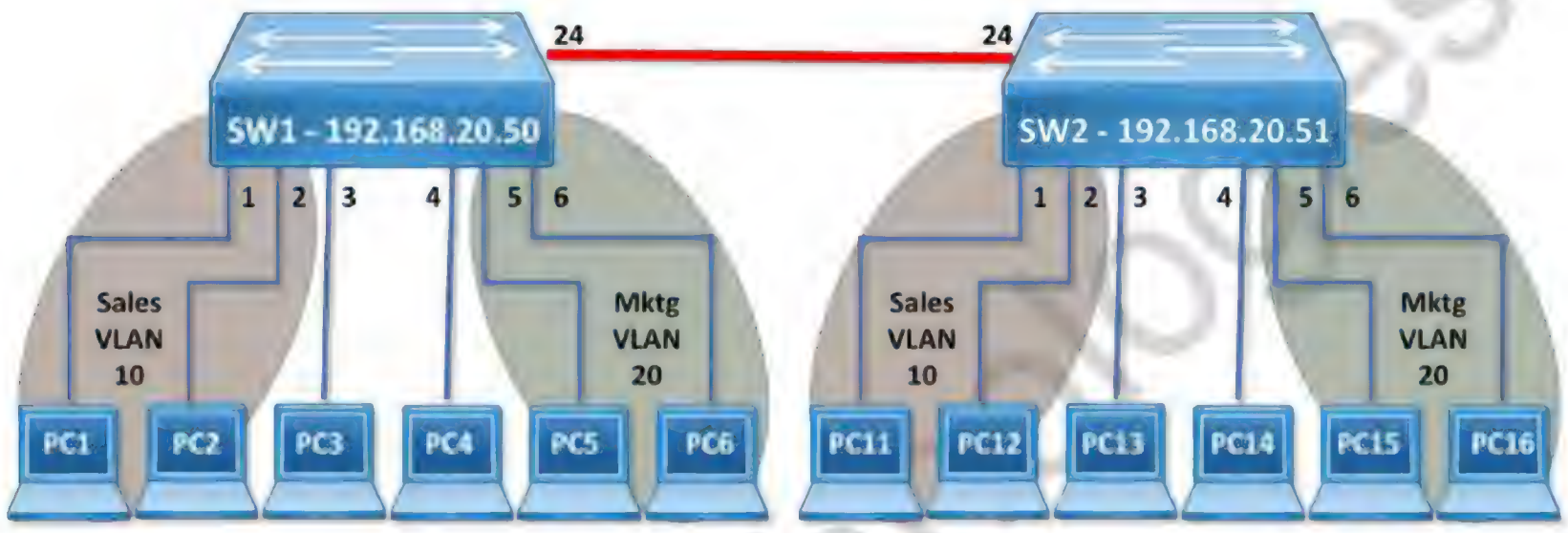
LAB 13: VLAN AND TRUNKING

OBJECTIVE:

To configure VLANs and trunking in a switched network.

TOPOLOGY:

Setup Switch and Computer connectivity for the lab as below:



TASK:

- Verify communication between the computers connected to same as well as a different switch.
- Verify Default VLAN information
- Configure and Implement VLANs
- Verify communication between the computers connected to same switch.
- Configure Trunking
- Verify communication between the computers connected to different switches.

Verify communication between the computers connected to same and different switches

From 192.168.20.1 computer (i.e. PC1) ping computers on the same switch

ping 192.168.20.2

```
PING 192.168.20.2 (192.168.20.2) 56(84) bytes of data.
64 bytes from 192.168.20.2: icmp_seq=1 ttl=62 time=24.0 ms
64 bytes from 192.168.20.2: icmp_seq=2 ttl=62 time=24.0 ms
64 bytes from 192.168.20.2: icmp_seq=3 ttl=62 time=24.1 ms
64 bytes from 192.168.20.2: icmp_seq=4 ttl=62 time=24.0 ms
```

ping 192.168.20.3

```
PING 192.168.20.3 (192.168.20.3) 56(84) bytes of data.
64 bytes from 192.168.20.3: icmp_seq=1 ttl=62 time=24.0 ms
64 bytes from 192.168.20.3: icmp_seq=2 ttl=62 time=24.0 ms
64 bytes from 192.168.20.3: icmp_seq=3 ttl=62 time=24.1 ms
64 bytes from 192.168.20.3: icmp_seq=4 ttl=62 time=24.0 ms
```

ping 192.168.20.5

```
PING 192.168.20.5 (192.168.20.5) 56(84) bytes of data.
64 bytes from 192.168.20.5: icmp_seq=1 ttl=62 time=24.0 ms
64 bytes from 192.168.20.5: icmp_seq=2 ttl=62 time=24.0 ms
64 bytes from 192.168.20.5: icmp_seq=3 ttl=62 time=24.1 ms
64 bytes from 192.168.20.5: icmp_seq=4 ttl=62 time=24.0 ms
```

From 192.168.20.1 computer (i.e. PC1) ping computers on the other switch

ping 192.168.20.12

```
PING 192.168.20.12 (192.168.20.12) 56(84) bytes of data.
64 bytes from 192.168.20.12: icmp_seq=1 ttl=62 time=24.0 ms
64 bytes from 192.168.20.12: icmp_seq=2 ttl=62 time=24.0 ms
64 bytes from 192.168.20.12: icmp_seq=3 ttl=62 time=24.1 ms
64 bytes from 192.168.20.12: icmp_seq=4 ttl=62 time=24.0 ms
```

ping 192.168.20.13

```
PING 192.168.20.13 (192.168.20.13) 56(84) bytes of data.
64 bytes from 192.168.20.13: icmp_seq=1 ttl=62 time=24.0 ms
64 bytes from 192.168.20.13: icmp_seq=2 ttl=62 time=24.0 ms
64 bytes from 192.168.20.13: icmp_seq=3 ttl=62 time=24.1 ms
64 bytes from 192.168.20.13: icmp_seq=4 ttl=62 time=24.0 ms
```

ping 192.168.20.15

PING 192.168.20.15 (192.168.20.15) 56(84) bytes of data.
64 bytes from 192.168.20.15: icmp_seq=1 ttl=62 time=24.0 ms
64 bytes from 192.168.20.15: icmp_seq=2 ttl=62 time=24.0 ms
64 bytes from 192.168.20.15: icmp_seq=3 ttl=62 time=24.1 ms
64 bytes from 192.168.20.15: icmp_seq=4 ttl=62 time=24.0 ms

Verify Default VLAN information

To view existing VLAN and port assigned to VLAN

SW1 – Verification:

SW1 # **show vlan brief**

```
VLAN Name              Status    Ports
---- ----------------------------- --------- -------------------------------
1    default           active    Fa0/1, Fa0/2, Fa0/3, Fa0/4, Fa0/5, Fa0/6, Fa0/7, Fa0/8, Fa0/9,
                                   Fa0/10, Fa0/11, Fa0/12, Fa0/13, Fa0/14, Fa0/15, Fa0/16, Fa0/17,
                                   Fa0/18, Fa0/19, Fa0/20, Fa0/21, Fa0/22, Fa0/23,Fa0/24
1002 fddi-default      act/unsup
1003 trcrf-default     act/unsup
1004 fddinet-default   act/unsup
1005 trbrf-default     act/unsup
SW1 #
```

SW2 – Verification:

SW2 # **show vlan brief**

```
VLAN Name              Status    Ports
---- ----------------------------- --------- -------------------------------
1    default           active    Fa0/1, Fa0/2, Fa0/3, Fa0/4, Fa0/5, Fa0/6, Fa0/7, Fa0/8, Fa0/9,
                                   Fa0/10, Fa0/11, Fa0/12, Fa0/13, Fa0/14, Fa0/15, Fa0/16, Fa0/17,
                                   Fa0/18, Fa0/19, Fa0/20, Fa0/21, Fa0/22, Fa0/23,Fa0/24
1002 fddi-default      act/unsup
1003 trcrf-default     act/unsup
1004 fddinet-default   act/unsup
1005 trbrf-default     act/unsup
SW2 #
```

Configure and Implement VLAN

SW1 – Configuration

SW1 #**configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
SW1 (config) # **vlan 10**
SW1 (config-vlan) # **name SALES**
SW1 (config-vlan) #**exit**
SW1 (config) # **vlan 20**
SW1 (config-vlan) # **name MKTG**
SW1 (config-vlan) #**exit**
SW1 (config) #

SW1 (config) # **interface range fastethernet 0/1 -2**
SW1 (config-if-range) # **switchport mode access**
SW1 (config-if-range) # **switchport access vlan 10**
SW1 (config-if-range) # **exit**
SW1(config) #
SW1 (config) # **interface range fastethernet 0/5 -6**
SW1 (config-if-range) # **switchport mode access**
SW1 (config-if-range) # **switchport access vlan 20**
SW1 (config-if-range) # **exit**

SW2 – Configuration

SW2 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
SW2 (config) # **vlan 10**
SW2 (config-vlan) # **name SALES**
SW2 (config-vlan) #**exit**
SW2 (config) # **vlan 20**
SW2 (config-vlan) # **name MKTG**
SW2 (config-vlan) #**exit**
SW2 (config) #

SW2 (config) # **interface range fastethernet 0/1 -2**
SW2 (config-if-range) # **switchport mode access**
SW2 (config-if-range) # **switchport access vlan 10**
SW2 (config-if-range) # **exit**
SW2(config) #
SW2 (config) # **interface range fastethernet 0/5 -6**
SW2 (config-if-range) # **switchport mode access**
SW2 (config-if-range) # **switchport access vlan 20**
SW2 (config-if-range) # **exit**

To view existing VLAN and port assigned to VLAN

SW1 – Verification:

SW1 # **show vlan brief**

```
VLAN Name                Status    Ports
---- ------------------------------ --------- -------------------------------
1    default             active    Fa0/3, Fa0/4, Fa0/7, Fa0/8, Fa0/9, Fa0/10, Fa0/11, Fa0/12, Fa0/13,
                                   Fa0/14, Fa0/15, Fa0/16, Fa0/17, Fa0/18, Fa0/19, Fa0/20, Fa0/21,
                                   Fa0/22, Fa0/23, Fa0/24
10   SALES               active    Fa0/1, Fa0/2
20   MKTG                active    Fa0/5, Fa0/6
1002 fddi-default        act/unsup
1003 trcrf-default       act/unsup
1004 fddinet-default     act/unsup
1005 trbrf-default       act/unsup
SW1 #
```

SW2 – Verification:

SW2 # **show vlan brief**

```
VLAN Name                Status    Ports
---- ------------------------------ --------- -------------------------------
1    default             active    Fa0/3, Fa0/4, Fa0/7, Fa0/8, Fa0/9, Fa0/10, Fa0/11, Fa0/12, Fa0/13,
                                   Fa0/14, Fa0/15, Fa0/16, Fa0/17, Fa0/18, Fa0/19, Fa0/20, Fa0/21,
                                   Fa0/22, Fa0/23, Fa0/24
10   SALES               active    Fa0/1, Fa0/2
20   MKTG                active    Fa0/5, Fa0/6
1002 fddi-default        act/unsup
1003 trcrf-default       act/unsup
1004 fddinet-default     act/unsup
1005 trbrf-default       act/unsup
SW2 #
```

Verify communication between the computers connected to same switch.

From 192.168.20.1 computer (i.e. PC1)

ping 192.168.20.2

PING 192.168.20.2 (192.168.20.2) 56(84) bytes of data.
64 bytes from 192.168.20.2: icmp_seq=1 ttl=62 time=24.0 ms
64 bytes from 192.168.20.2: icmp_seq=2 ttl=62 time=24.0 ms
64 bytes from 192.168.20.2: icmp_seq=3 ttl=62 time=24.1 ms
64 bytes from 192.168.20.2: icmp_seq=4 ttl=62 time=24.0 ms

ping 192.168.20.3

PING 192.168.20.3 (192.168.20.3) 56(84) bytes of data.
From 192.168.20.1 icmp_seq=1 Destination Host Unreachable
From 192.168.20.1 icmp_seq=2 Destination Host Unreachable
From 192.168.20.1 icmp_seq=3 Destination Host Unreachable
From 192.168.20.1 icmp_seq=3 Destination Host Unreachable

ping 192.168.20.5

PING 192.168.20.5 (192.168.20.5) 56(84) bytes of data.
From 192.168.20.1 icmp_seq=1 Destination Host Unreachable
From 192.168.20.1 icmp_seq=2 Destination Host Unreachable
From 192.168.20.1 icmp_seq=3 Destination Host Unreachable
From 192.168.20.1 icmp_seq=3 Destination Host Unreachable

From 192.168.20.6 computer (i.e. PC6)

ping 192.168.20.2

PING 192.168.20.2 (192.168.20.2) 56(84) bytes of data.
From 192.168.20.6 icmp_seq=1 Destination Host Unreachable
From 192.168.20.6 icmp_seq=2 Destination Host Unreachable
From 192.168.20.6 icmp_seq=3 Destination Host Unreachable
From 192.168.20.6 icmp_seq=3 Destination Host Unreachable

ping 192.168.20.5

PING 192.168.20.5 (192.168.20.5) 56(84) bytes of data.
64 bytes from 192.168.20.5: icmp_seq=1 ttl=62 time=24.0 ms
64 bytes from 192.168.20.5: icmp_seq=2 ttl=62 time=24.0 ms
64 bytes from 192.168.20.5: icmp_seq=3 ttl=62 time=24.1 ms
64 bytes from 192.168.20.5: icmp_seq=4 ttl=62 time=24.0 ms

Configure Trunking

SW1 – Configuration

SW1 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
SW1 (config)# **interface fastethernet 0/24**
SW1 (config-if)# **switchport mode trunk**
SW1 (config-if)# **switchport trunk allowed vlan all**
SW1 (config-if)# **^Z**
SW1 #

SW2 – Configuration

SW2 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
SW2 (config)# **interface fastethernet 0/24**
SW2 (config-if)# **switchport mode trunk**
SW2 (config-if)# **switchport trunk allowed vlan all**
SW2 (config-if)# **^Z**
SW2 #

Verify trunk configuration

SW1 – Verification:

SW1 # **show interface trunk**

Port	Mode	Encapsulation	Status	Native vlan
Fa0/24	on	802.1q	trunking	1

Port	Vlans allowed on trunk
Fa0/24	1-4094

Port	Vlans allowed and active in management domain
Fa0/24	1,10,20

Port	Vlans in spanning tree forwarding state and not pruned
Fa0/24	none

SW1 #

SW2 – Verification:

SW2 # **show interface trunk**

Port	Mode	Encapsulation	Status	Native vlan
Fa0/24	on	802.1q	trunking	1

Port	Vlans allowed on trunk
Fa0/24	1-4094

Port	Vlans allowed and active in management domain
Fa0/24	1,10,20

Port	Vlans in spanning tree forwarding state and not pruned
Fa0/24	none

SW2 #

Verify communication between the computers connected to different switch.

From 192.168.20.1 computer (i.e. PC1)

ping 192.168.20.12

PING 192.168.20.12 (192.168.20.12) 56(84) bytes of data.
64 bytes from 192.168.20.12: icmp_seq=1 ttl=62 time=24.0 ms
64 bytes from 192.168.20.12: icmp_seq=2 ttl=62 time=24.0 ms
64 bytes from 192.168.20.12: icmp_seq=3 ttl=62 time=24.1 ms
64 bytes from 192.168.20.12: icmp_seq=4 ttl=62 time=24.0 ms

ping 192.168.20.13

PING 192.168.20.13 (192.168.20.13) 56(84) bytes of data.
From 192.168.20.1 icmp_seq=1 Destination Host Unreachable
From 192.168.20.1 icmp_seq=2 Destination Host Unreachable
From 192.168.20.1 icmp_seq=3 Destination Host Unreachable
From 192.168.20.1 icmp_seq=3 Destination Host Unreachable

ping 192.168.20.15

PING 192.168.20.15 (192.168.20.15) 56(84) bytes of data.
From 192.168.20.1 icmp_seq=1 Destination Host Unreachable
From 192.168.20.1 icmp_seq=2 Destination Host Unreachable
From 192.168.20.1 icmp_seq=3 Destination Host Unreachable
From 192.168.20.1 icmp_seq=3 Destination Host Unreachable

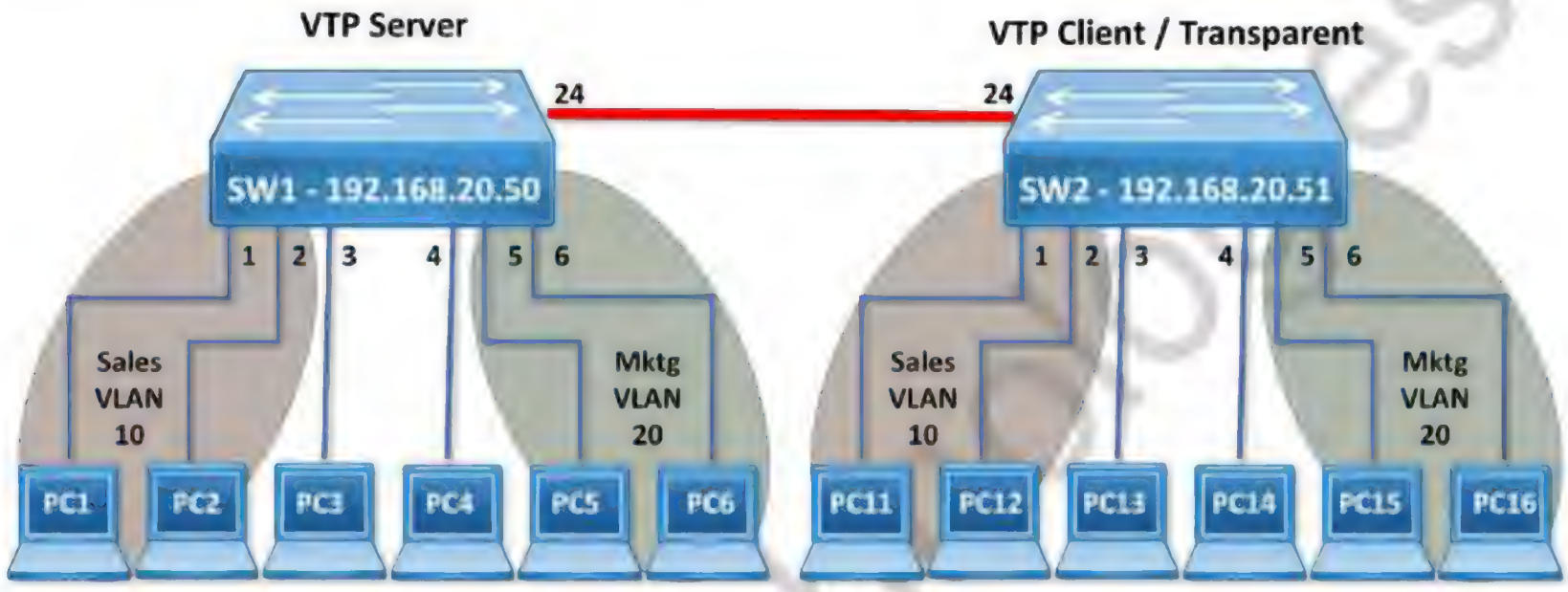
LAB 14: VLAN TRUNKING PROTOCOL (VTP)

OBJECTIVE:

To implement VTP on switches across the network.

TOPOLOGY:

Setup Switch connectivity for the lab as below :



Pre-requisite: VLAN and Trunking configuration to be done on the Switch (LAB – 13)

TASK:

- Configure VTP
- Verify the working of VTP

Configure VTP

SW1 – VTP Server Configuration

SW1 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
SW1 (config) # **vtp domain ZOOM**
Changing VTP domain name from null to ZOOM
SW1 (config) # **vtp password CCNA**
Setting device VLAN database password to CCNA
SW1 (config) # **^Z**
SW1 #

SW2 – VTP Client Configuration

SW2 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
SW2 (config) # **vtp domain ZOOM**
Changing VTP domain name from null to ZOOM
SW2 (config) # **vtp password CCNA**
Setting device VLAN database password to CCNA
SW2 (config) # **vtp mode client**
Setting device to VTP CLIENT mode.
SW2 (config) # **^Z**
SW2 #

SW1 – Verification:

SW1 # **show vtp status**

VTP Version	:	2
Configuration Revision	:	0
Maximum VLANs supported locally	:	64
Number of existing VLANs	:	5
VTP Operating Mode	:	Server
VTP Domain Name	:	ZOOM
VTP Pruning Mode	:	Disabled
VTP V2 Mode	:	Disabled
VTP Traps Generation	:	Disabled
MD5 digest	:	0x4C 0x9A 0xF5 0x6A 0x05 0xBA 0x83 0xE3

Configuration last modified by 192.168.20.50 at 3-1-93 02:26:12
SW1#

SW1 # **show vtp password**
VTP Password: CCNA
SW1#

SW2 – Verification:

SW2 # **show vtp status**

VTP Version	:	2
Configuration Revision	:	0
Maximum VLANs supported locally	:	64
Number of existing VLANs	:	5
VTP Operating Mode	:	Client
VTP Domain Name	:	ZOOM
VTP Pruning Mode	:	Disabled
VTP V2 Mode	:	Disabled
VTP Traps Generation	:	Disabled
MD5 digest	:	0x4C 0x9A 0xF5 0x6A 0x05 0xBA 0x83 0xE3

Configuration last modified by 192.168.20.50 at 3-1-93 02:26:12
Local updater ID is 192.168.20.50 on interface Vl1 (lowest numbered VLAN interface found)
SW1#

SW2 # **show vtp password**
VTP Password: CCNA
SW2#

Verify the working of VTP

Create VLANs on Server Switch i.e. **SW1** and verify that these VLANs are automatically available on Client Switch i.e. **SW2**.

SW1 – Configuration

SW1 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
SW1 (config) # **vlan 10**
SW1 (config-vlan) # **name SALES**
SW1 (config-vlan) #**exit**
SW1 (config) # **vlan 20**
SW1 (config-vlan) # **name MKTG**
SW1 (config-vlan) #**exit**
SW1 (config) #

SW1 – Verification:

SW1 # **show vlan brief**

VLAN	Name	Status	Ports
1	default	active	Fa0/3, Fa0/4, Fa0/7, Fa0/8, Fa0/9, Fa0/10, Fa0/11, Fa0/12, Fa0/13,

```
                                  Fa0/14, Fa0/15, Fa0/16, Fa0/17, Fa0/18, Fa0/19, Fa0/20, Fa0/21,
                                  Fa0/22, Fa0/23, Fa0/24
10   SALES                active
20   MKTG                 active
1002 fddi-default         act/unsup
1003 trcrf-default        act/unsup
1004 fddinet-default      act/unsup
1005 trbrf-default        act/unsup
SW1 #
```

SW2 – Verification:

SW2 # **show vlan brief**

```
VLAN Name                Status    Ports
---- ----------------------------- --------- -------------------------------
1    default             active    Fa0/3, Fa0/4, Fa0/7, Fa0/8, Fa0/9, Fa0/10, Fa0/11, Fa0/12, Fa0/13,
                                   Fa0/14, Fa0/15, Fa0/16, Fa0/17, Fa0/18, Fa0/19, Fa0/20, Fa0/21,
                                   Fa0/22, Fa0/23, Fa0/24
10   SALES                active
20   MKTG                 active
1002 fddi-default         act/unsup
1003 trcrf-default        act/unsup
1004 fddinet-default      act/unsup
1005 trbrf-default        act/unsup
SW2 #
```

Try to create VLANs on Client Switch i.e. SW2

SW2 – Verification:

SW2 (config) # **vlan 100**
VTP VLAN configuration not allowed when device is in CLIENT mode.

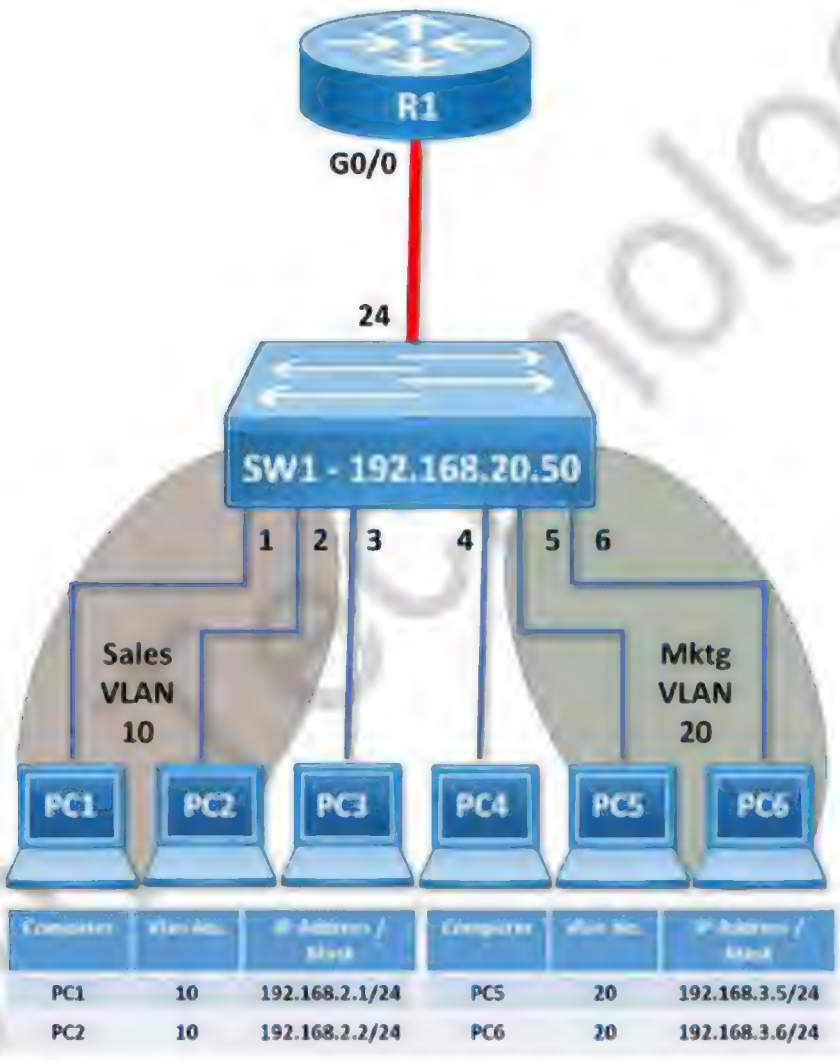
LAB 15: ROUTER ON A STICK (INTER-VLAN ROUTING)

OBJECTIVE:

To configure inter-vlan routing for communication between VLANs, by configuring sub interfaces on a router.

TOPOLOGY:

Setup connectivity for the lab as below :



PC1	10	192.168.2.1/24	PC5	20	192.168.3.5/24
PC2	10	192.168.2.2/24	PC6	20	192.168.3.6/24

Pre-requisite: VLAN configuration to be done on the switch (LAB – 13)

TASK:

- Verify communication between the computers in Different VLAN
- Configure Sub Interfaces and IP Routing on Router
- Verify communication between the computers in Different VLAN

Verify communication between the computers in Different VLAN

From 192.168.2.1 computer (i.e. PC1)

ping 192.168.2.2

PING 192.168.2.2 (192.168.2.2) 56(84) bytes of data.
64 bytes from 192.168.2.2: icmp_seq=1 ttl=62 time=24.0 ms
64 bytes from 192.168.2.2: icmp_seq=2 ttl=62 time=24.0 ms
64 bytes from 192.168.2.2: icmp_seq=3 ttl=62 time=24.1 ms
64 bytes from 192.168.2.2: icmp_seq=4 ttl=62 time=24.0 ms

ping 192.168.3.5

PING 192.168.3.5 (192.168.3.5) 56(84) bytes of data.
From 192.168.2.1 icmp_seq=1 Destination Host Unreachable
From 192.168.2.1 icmp_seq=2 Destination Host Unreachable
From 192.168.2.1 icmp_seq=3 Destination Host Unreachable
From 192.168.2.1 icmp_seq=3 Destination Host Unreachable

From 192.168.3.6 computer (i.e. PC6)

ping 192.168.2.2

PING 192.168.2.2 (192.168.2.2) 56(84) bytes of data.
From 192.168.3.6 icmp_seq=1 Destination Host Unreachable
From 192.168.3.6 icmp_seq=2 Destination Host Unreachable
From 192.168.3.6 icmp_seq=3 Destination Host Unreachable
From 192.168.3.6 icmp_seq=3 Destination Host Unreachable

ping 192.168.3.5

PING 192.168.3.5 (192.168.3.5) 56(84) bytes of data.
64 bytes from 192.168.3.5: icmp_seq=1 ttl=62 time=24.0 ms
64 bytes from 192.168.3.5: icmp_seq=2 ttl=62 time=24.0 ms
64 bytes from 192.168.3.5: icmp_seq=3 ttl=62 time=24.1 ms
64 bytes from 192.168.3.5: icmp_seq=4 ttl=62 time=24.0 ms

Configure Sub Interfaces and IP Routing on Router

R1 – Configuration

R1 (config) # **interface gigabitEthernet 0/0**
R1 (config-subif) # **no shutdown**
R1 (config) # **interface gigabitEthernet 0/0.1**
R1 (config-subif) # **encapsulation dot1q 10**
R1 (config-subif) # **ip address 192.168.2.254 255.255.255.0**
R1 (config-subif) # **exit**
R1 (config) # **interface gigabitEthernet 0/0.2**
R1 (config-subif) # **encapsulation dot1q 20**
R1 (config-subif) # **ip address 192.168.3.254 255.255.255.0**
R1 (config-subif) # **exit**
R1 (config) # **ip routing**
R1 (config) #

R1 – Verification

R1 # **show ip route**
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2
i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
ia - IS-IS inter area, * - candidate default, U - per-user static route
o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
+ - replicated route, % - next hop override

Gateway of last resort is not set

192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.2.0/24 is directly connected, GigabitEthernet0/0.1
L 192.168.2.254/32 is directly connected, GigabitEthernet0/0.1
192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.3.0/24 is directly connected, GigabitEthernet0/0.2
L 192.168.3.254/32 is directly connected, GigabitEthernet0/0.2
R1 #

Verify communication between the computers in Different VLAN

From 192.168.2.1 computer (i.e. PC1)

ping 192.168.2.2

PING 192.168.2.2 (192.168.2.2) 56(84) bytes of data.
64 bytes from 192.168.2.2: icmp_seq=1 ttl=62 time=24.0 ms
64 bytes from 192.168.2.2: icmp_seq=2 ttl=62 time=24.0 ms
64 bytes from 192.168.2.2: icmp_seq=3 ttl=62 time=24.1 ms
64 bytes from 192.168.2.2: icmp_seq=4 ttl=62 time=24.0 ms

ping 192.168.3.5

PING 192.168.3.5 (192.168.3.5) 56(84) bytes of data.
64 bytes from 192.168.3.5: icmp_seq=1 ttl=62 time=24.0 ms
64 bytes from 192.168.3.5: icmp_seq=2 ttl=62 time=24.0 ms
64 bytes from 192.168.3.5: icmp_seq=3 ttl=62 time=24.1 ms
64 bytes from 192.168.3.5: icmp_seq=4 ttl=62 time=24.0 ms

From 192.168.3.6 computer (i.e. PC6)

ping 192.168.2.2

PING 192.168.2.2 (192.168.2.2) 56(84) bytes of data.
64 bytes from 192.168.2.2: icmp_seq=1 ttl=62 time=24.0 ms
64 bytes from 192.168.2.2: icmp_seq=2 ttl=62 time=24.0 ms
64 bytes from 192.168.2.2: icmp_seq=3 ttl=62 time=24.1 ms
64 bytes from 192.168.2.2: icmp_seq=4 ttl=62 time=24.0 ms

ping 192.168.3.5

PING 192.168.3.5 (192.168.3.5) 56(84) bytes of data.
64 bytes from 192.168.3.5: icmp_seq=1 ttl=62 time=24.0 ms
64 bytes from 192.168.3.5: icmp_seq=2 ttl=62 time=24.0 ms
64 bytes from 192.168.3.5: icmp_seq=3 ttl=62 time=24.1 ms
64 bytes from 192.168.3.5: icmp_seq=4 ttl=62 time=24.0 ms

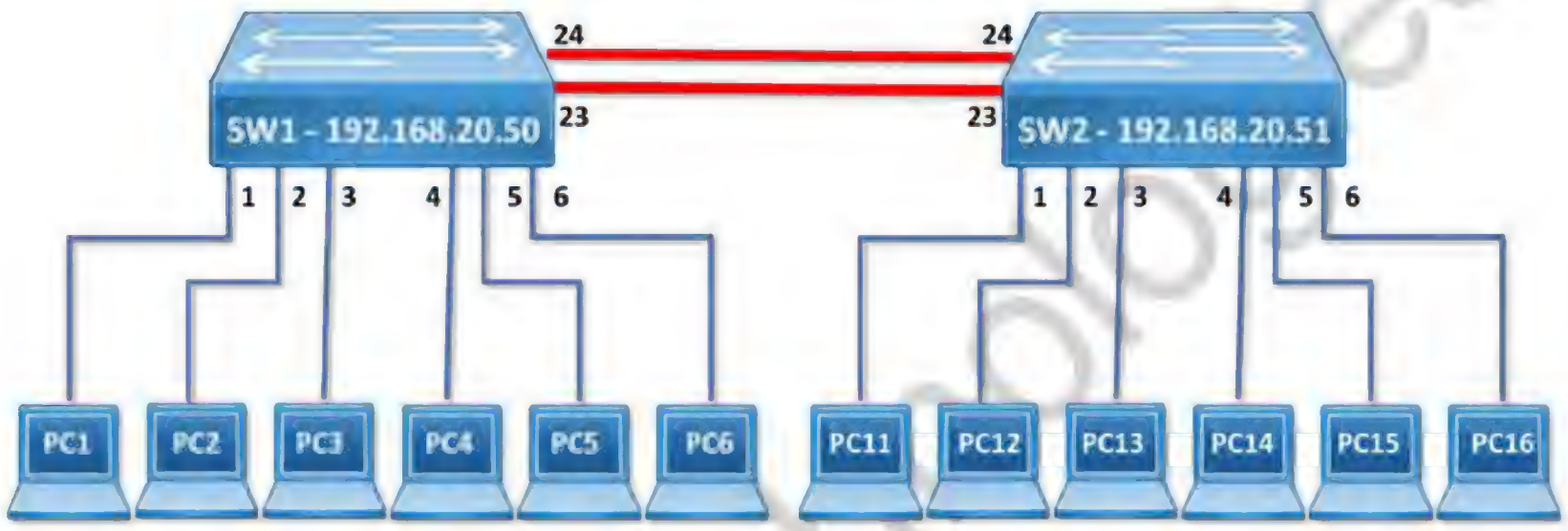
LAB 16: SPANNING TREE PROTOCOL (STP)

OBJECTIVE:

To understand the default behaviour of STP and how a root bridge election takes place.

TOPOLOGY:

Setup Switch connectivity for the lab as below :



TASK:

- Verify STP behaviour
- Change Priority to force a particular switch to become the Root Bridge
- Verify STP

Verify STP default behaviour

SW1 – Verification:

SW1 # **show spanning-tree**
VLAN0001
Spanning tree enabled protocol ieee

Root ID	Priority	32769		
	Address	000c.8577.2040		
	Cost	19		
	Port	23 (FastEthernet0/23)		
	Hello Time	2 sec	Max Age 20 sec	Forward Delay 15 sec

Bridge ID	Priority	32769 (priority 32768 sys-id-ext 1)		
Address	000d.28f0.6840			
Hello Time	2 sec	Max Age 20 sec	Forward Delay 15 sec	
Aging Time	15			

Interface	Role	Sts	Cost	Prio.Nbr	Type
Fa0/7	Desg	FWD	19	128.7	P2p
Fa0/11	Desg	LIS	19	128.11	P2p
Fa0/13	Desg	FWD	19	128.13	P2p
Fa0/19	Desg	FWD	19	128.19	P2p
Fa0/23	Root	FWD	19	128.23	P2p
Fa0/24	Altn	BLK	19	128.24	P2p

SW1 #

SW2 – Verification:

SW2 # **show spanning-tree**
VLAN0001
Spanning tree enabled protocol ieee

Root ID	Priority	32769		
	Address	000c.8577.2040		
	This bridge is the root			
	Hello Time	2 sec	Max Age 20 sec	Forward Delay 15 sec

Bridge ID	Priority	32769 (priority 32768 sys-id-ext 1)		
Address	000c.8577.2040			
Hello Time	2 sec	Max Age 20 sec	Forward Delay 15 sec	
Aging Time	15			

Interface	Role	Sts	Cost	Prio.Nbr	Type
Fa0/7	Desg	FWD	19	128.7	P2p
Fa0/13	Desg	FWD	19	128.13	P2p
Fa0/19	Desg	FWD	19	128.19	P2p
Fa0/23	Desg	FWD	19	128.23	P2p
Fa0/24	Desg	FWD	19	128.24	P2p

SW2 #

Change Priority to force a particular switch to become the Root Bridge

By changing the priority on the switch, we can force a switch to become the Root Bridge. The switch with the lowest priority becomes the Root Bridge with all ports in forwarding state.

SW1 – Configuration

SW1 (config) # **spanning-tree vlan 1 priority 4096**
SW1 (config) #**^Z**
SW1 #

Verify STP

SW1 – Verification:

SW1 # **show spanning-tree**
VLAN0001
Spanning tree enabled protocol ieee

Root ID	Priority	4097			
	Address	000d.28f0.6840			
	This bridge is the root				
	Hello Time	2 sec	Max Age 20 sec		Forward Delay 15 sec
Bridge ID	Priority	4096 (priority 4096 sys-id-ext 1)			
	Address	000d.28f0.6840			
	Hello Time	2 sec	Max Age 20 sec		Forward Delay 15 sec
	Aging Time	15			

Interface	Role	Sts	Cost	Prio.Nbr	Type
Fa0/7	Desg	FWD	19	128.7	P2p
Fa0/11	Desg	LIS	19	128.11	P2p
Fa0/13	Desg	FWD	19	128.13	P2p
Fa0/19	Desg	FWD	19	128.19	P2p
Fa0/23	Desg	FWD	19	128.23	P2p
Fa0/24	Desg	FWD	19	128.24	P2p

SW1 #

SW2 – Verification:

SW2 # **show spanning-tree**
VLAN0001
Spanning tree enabled protocol ieee

Root ID	Priority	4097			
	Address	000d.28f0.6840			
	Cost	19			
	Port	23 (FastEthernet0/23)			
	Hello Time	2 sec	Max Age 20 sec		Forward Delay 15 sec

```
Bridge ID        Priority         32769  (priority 32768 sys-id-ext 1)
     Address     000c.8577.2040
     Hello Time  2 sec            Max Age 20 sec          Forward Delay 15 sec
     Aging Time  15

Interface        Role      Sts      Cost      Prio.Nbr      Type
---------------- ----  --- --------- -------- --------------------------------
Fa0/7            Desg      FWD      19        128.7         P2p
Fa0/13           Desg      FWD      19        128.13        P2p
Fa0/19           Desg      FWD      19        128.19        P2p
Fa0/23           Root      FWD      19        128.23        P2p
Fa0/24           Altn      BLK      19        128.24        P2p

SW2 #
```

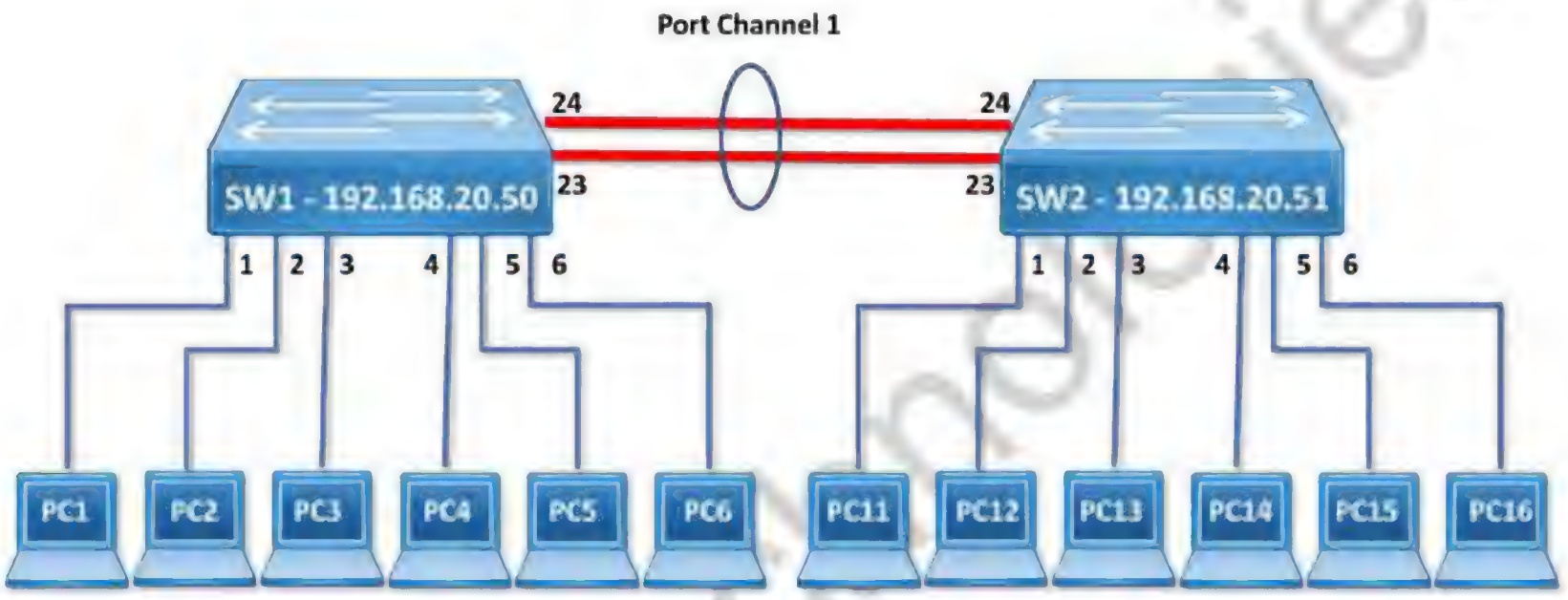
LAB 17: ETHERCHANNEL

OBJECTIVE:

To configure Etherchannel for link aggregation

TOPOLOGY:

Setup Switch connectivity for the lab as below :



TASK:

- Configure Etherchannel
- Verify Etherchannel

Configure Etherchannel

SW1 – Etherchannel Configuration

SW1 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
SW1 (config) # **interface range fa 0/23 -24**
SW1 (config-if-range) # **channel-group 1 mode on**
Creating a port-channel interface Port-channel 1
SW1 (config-if-range) # **^Z**
SW1 #

SW2 – Etherchannel Configuration

SW2 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
SW2 (config) # **interface range fa 0/23 -24**
SW2 (config-if-range) # **channel-group 1 mode on**
Creating a port-channel interface Port-channel 1
SW2 (config-if-range) # **^Z**
SW2 #

Verify Etherchannel

SW1 – Verification:

SW1 # **show etherchannel 1 summary**
Flags: D - down P - bundled in port-channel
I - stand-alone s - suspended
H - Hot-standby (LACP only)
R - Layer3 S - Layer2
U - in use f - failed to allocate aggregator

M - not in use, minimum links not met
u - unsuitable for bundling
w - waiting to be aggregated
d - default port

Number of channel-groups in use: 1
Number of aggregators: 1

Group	Port-channel	Protocol	Ports
1	Po1(SU)	-	Fa0/23(P) Fa0/24(P)

SW1 #

SW2 – Verification:

SW2 # **show etherchannel 1 summary**

```
Flags:  D - down        P - bundled in port-channel
        I - stand-alone s - suspended
        H - Hot-standby (LACP only)
        R - Layer3      S - Layer2
        U - in use      f - failed to allocate aggregator

        M - not in use, minimum links not met
        u - unsuitable for bundling
        w - waiting to be aggregated
        d - default port

Number of channel-groups in use: 1
Number of aggregators: 1

Group  Port-channel  Protocol    Ports
------+-------------+-----------+-----------------------------------------------
1      Po1(SU)         -        Fa0/23(P) Fa0/24(P)
SW2 #
```

LAB 18: PORT SECURITY

OBJECTIVE:

To implement Port Security on switches across the network.

TOPOLOGY:

Setup Switch connectivity for the lab as below :

TASK:

- Configure Port Security
- Verify Port Security violation

Configure Port Security

SW1 (config)# **interface fastethernet 0/2**
SW1 (config-if)# **switchport mode access**
SW1 (config-if)# **switchport port-security maximum 1**
SW1 (config-if)# **switchport port-security mac-address 0013.20B7.1232**
SW1 (config-if)# **switchport port-security violation shutdown**
SW1 (config-if)# **switchport port-security**
SW1 (config-if)# **^Z**
SW1 #

Verify Port Security Violation

Connect another computer (with different mac-address) to switch port no. 2 and verify the output.

SW1 – Verification:

SW1 # **show interface status**

Port	Name	Status	Vlan	Duplex	Speed	Type
Fa0/1		connected	1	a-full	a-100	10/100BaseTX
Fa0/2		err-disabled	1	auto	auto	10/100BaseTX
Fa0/3		connected	1	a-full	a-100	10/100BaseTX

!
<output omitted>
!
Fa0/24 connected 1 a-full a-100 10/100BaseTX
SW1#

SW1 # **show port-security**

Secure Port	MaxSecureAddr (Count)	CurrentAddr (Count)	SecurityViolation (Count)	Security Action
Fa0/2	1	1	1	Shutdown

Total Addresses in System (excluding one mac per port) : 0
Max Addresses limit in System (excluding one mac per port) : 1024
SW1 #

Repeat the above steps by reconfiguring violation command (restrict and protect) and verify the output.

SW1 (config-if)# **switchport port-security violation restrict**
OR
SW1 (config-if)# **switchport port-security violation protect**

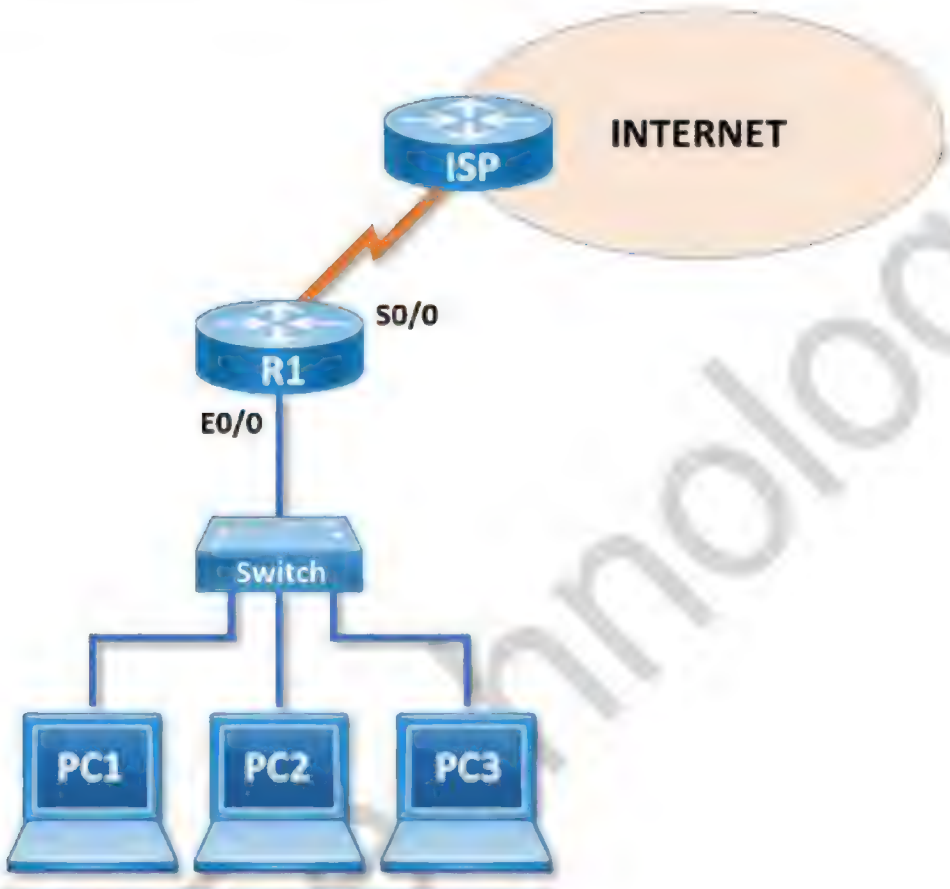
LAB 19: DEFAULT ROUTING

OBJECTIVE:

To configure default routing for accessing Internet.

TOPOLOGY:

Setup Ethernet and Serial connectivity for the lab as below :



Interface	IP Address / Mask
E0/0	192.168.2.1/24
S0/0	202.1.0.18/29

TASK:

- Configure WAN Interface
- Configure Default Routing
- Verify Default Routing
- Verify communication from LAN to the Internet

Configure WAN Interface

Configure WAN Interface IP address according to topology diagram (i.e. IP addresses provided by ISP)

R1 – Configuration

R1 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R1 (config)# **interface serial 0/0**
R1 (config-if)# **ip address 202.1.0.18 255.255.255.248**
R1 (config-if)# **no shutdown**
R1 (config-if)# **encapsulation ppp**
R1 (config-if)# **exit**
R1 (config)#

Configure Default Routing

R1 – Configuration

R1 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R1 (config) # **ip route 0.0.0.0 0.0.0.0 Serial0/0**
R1 (config) # **exit**
R1 (config) #

Verify Default Routing

Once Default routing is enabled IP Network defined through the **default routing command** is added into the routing information table. **"*"** represents **Default route.**

R1 – Verification:

R1 # **show ip route**

Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
* - candidate default, U - per-user static route, o - ODR
P - periodic downloaded static route

Gateway of last resort is not set

C 202.1.0.16/29 is directly connected, Serial0/0
C 192.168.2.0/24 is directly connected, Ethernet0/0
S* 0.0.0.0/0 [1/0] via Serial0/0
R1 #

Verify communication from LAN to the Internet.

Verification from PC1

ping 202.2.0.17

PING 202.2.0.17 (202.2.0.17) 56(84) bytes of data.
64 bytes from 202.2.0.17: icmp_seq=1 ttl=62 time=24.0 ms
64 bytes from 202.2.0.17: icmp_seq=2 ttl=62 time=24.0 ms
64 bytes from 202.2.0.17: icmp_seq=3 ttl=62 time=24.1 ms
64 bytes from 202.2.0.17: icmp_seq=4 ttl=62 time=24.0 ms

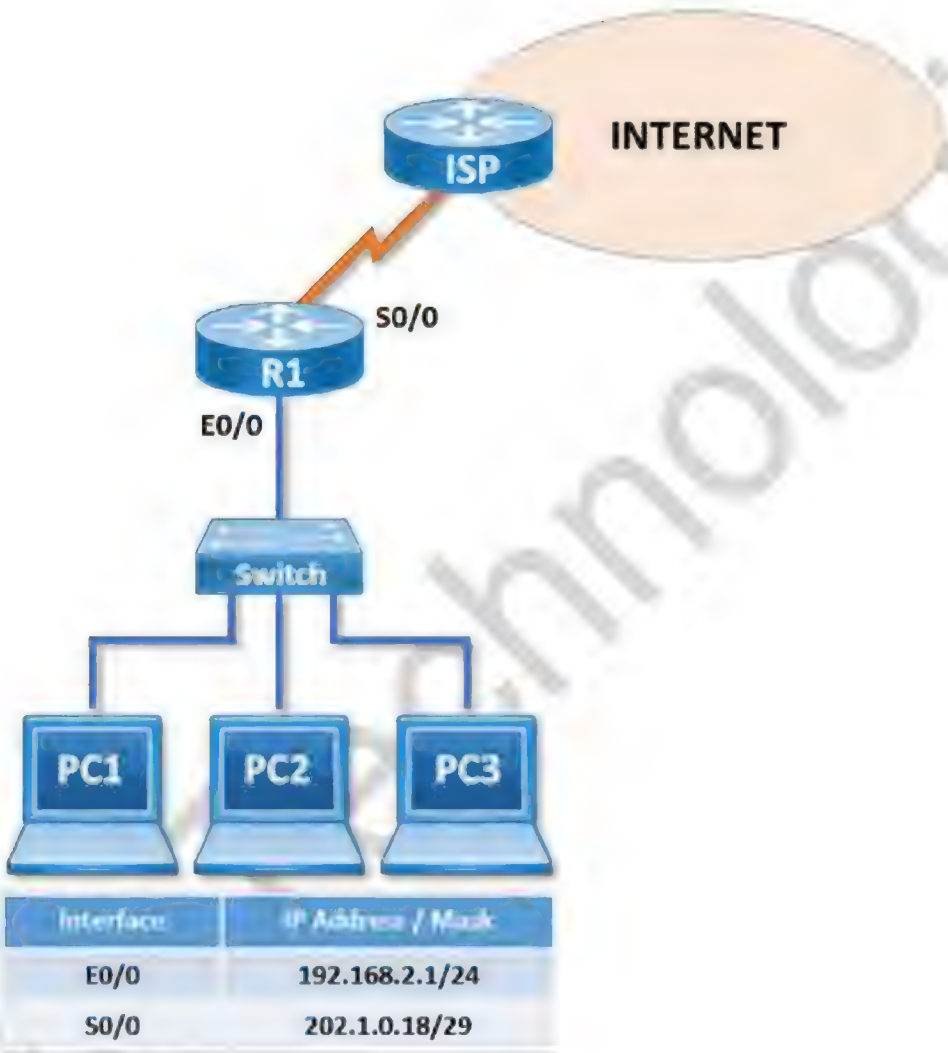
LAB 20: STATIC NAT

OBJECTIVE:

To configure Static NAT for Hosting Pubic Servers on the Internet.

TOPOLOGY:

Setup Ethernet and Serial connectivity for the lab as below :



Interface	IP Address / Mask
E0/0	192.168.2.1/24
S0/0	202.1.0.18/29

Pre-requisite: Default Routing configuration to be done on the router (LAB – 19)

TASK:

- Configure Static NAT
- Verify Static NAT

Configure Static NAT

R1 (config) # **interface serial 0/0**
R1 (config-if) # **ip nat outside**
R1 (config-if) # **exit**
R1 (config) # **interface ethernet 0/0**
R1 (config-if) # **ip nat inside**
R1 (config-if) # **exit**
R1 (config)# **ip nat inside source static 192.168.2.10 202.1.0.19**

Verify Static NAT

R1 – Verification

R1 # **show ip nat translation**

Pro	Inside global	Inside local	Outside local	Outside global
---	202.1.0.19	192.168.2.10	---	---

R1 #

Verification from Outside PC (Internet PC)

ping 202.1.0.19

PING 202.1.0.19 (202.1.0.19) 56(84) bytes of data.
64 bytes from 202.1.0.19: icmp_seq=1 ttl=62 time=24.0 ms
64 bytes from 202.1.0.19: icmp_seq=2 ttl=62 time=24.0 ms
64 bytes from 202.1.0.19: icmp_seq=3 ttl=62 time=24.1 ms
64 bytes from 202.1.0.19: icmp_seq=4 ttl=62 time=24.0 ms

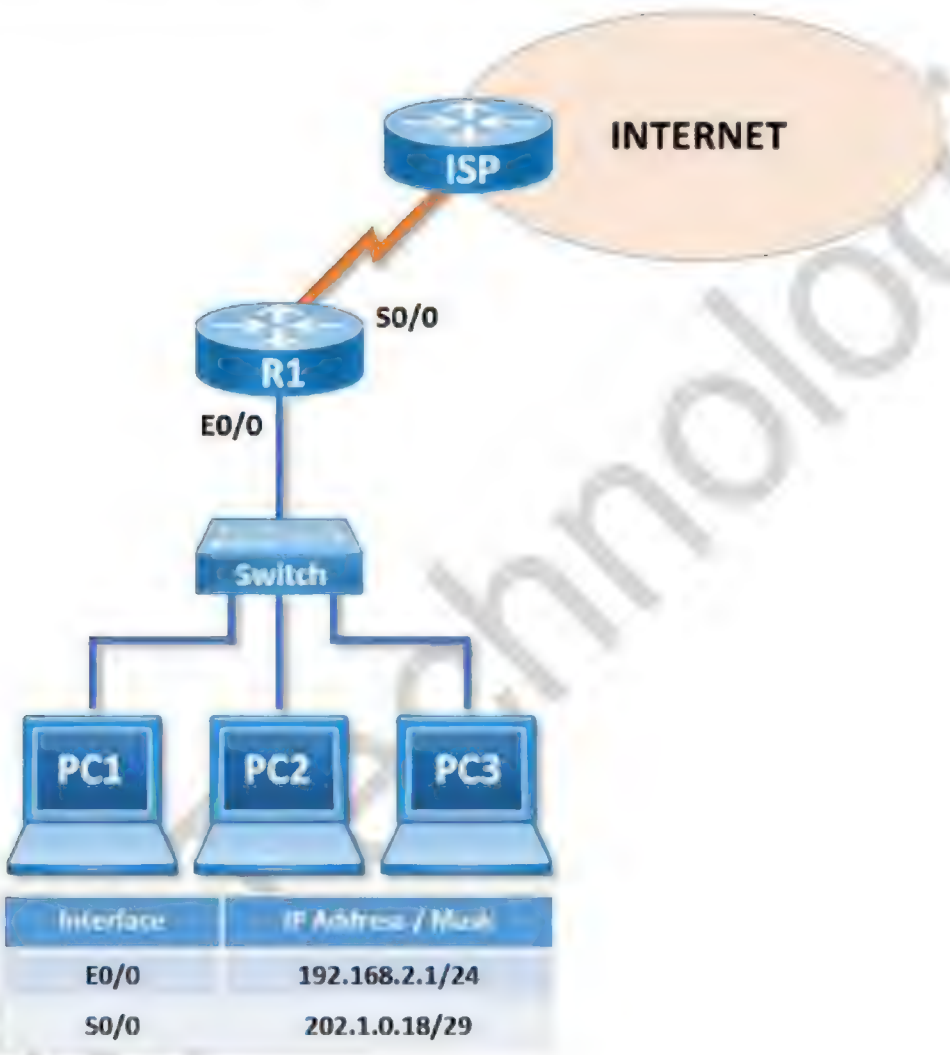
LAB 21: DYNAMIC NAT

OBJECTIVE:

To configure Dynamic NAT for the LAN users to access the Internet using a pool of Public IP Addresses.

TOPOLOGY:

Setup Ethernet and Serial connectivity for the lab as below :



Interface	IP Address / Mask
E0/0	192.168.2.1/24
S0/0	202.1.0.18/29

Pre-requisite: Default Routing configuration to be done on the router (LAB – 19)

TASK:

- Configure Dynamic NAT
- Verify Dynamic NAT

Configure Dynamic NAT

R1 (config) # **interface serial 0/0**
R1 (config-if) # **ip nat outside**
R1 (config-if) # **exit**
R1 (config) # **interface ethernet 0/0**
R1 (config-if) # **ip nat inside**
R1 (config-if) # **exit**
R1 (config) # **access-list 10 permit 192.168.2.0 0.0.0.255**
R1 (config) # **ip nat pool ZOOM 202.1.0.20 202.1.0.22 netmask 255.255.255.248**
R1 (config) # **ip nat inside source list 10 pool ZOOM**

Verify Dynamic NAT

R1 – Verification

R1 # **show ip nat translation**

Pro	Inside global	Inside local	Outside local	Outside global
icmp	202.1.0.20:1048	192.168.2.20:1048	202.2.0.17:1048	202.2.0.17:1048
icmp	202.1.0.21:1816	192.168.2.30:1816	202.2.0.17:1816	202.2.0.17:1816

R1 #

Verification from PC1

ping 202.2.0.17

PING 202.2.0.17 (202.2.0.17) 56(84) bytes of data.
64 bytes from 202.2.0.17: icmp_seq=1 ttl=62 time=24.0 ms
64 bytes from 202.2.0.17: icmp_seq=2 ttl=62 time=24.0 ms
64 bytes from 202.2.0.17: icmp_seq=3 ttl=62 time=24.1 ms
64 bytes from 202.2.0.17: icmp_seq=4 ttl=62 time=24.0 ms

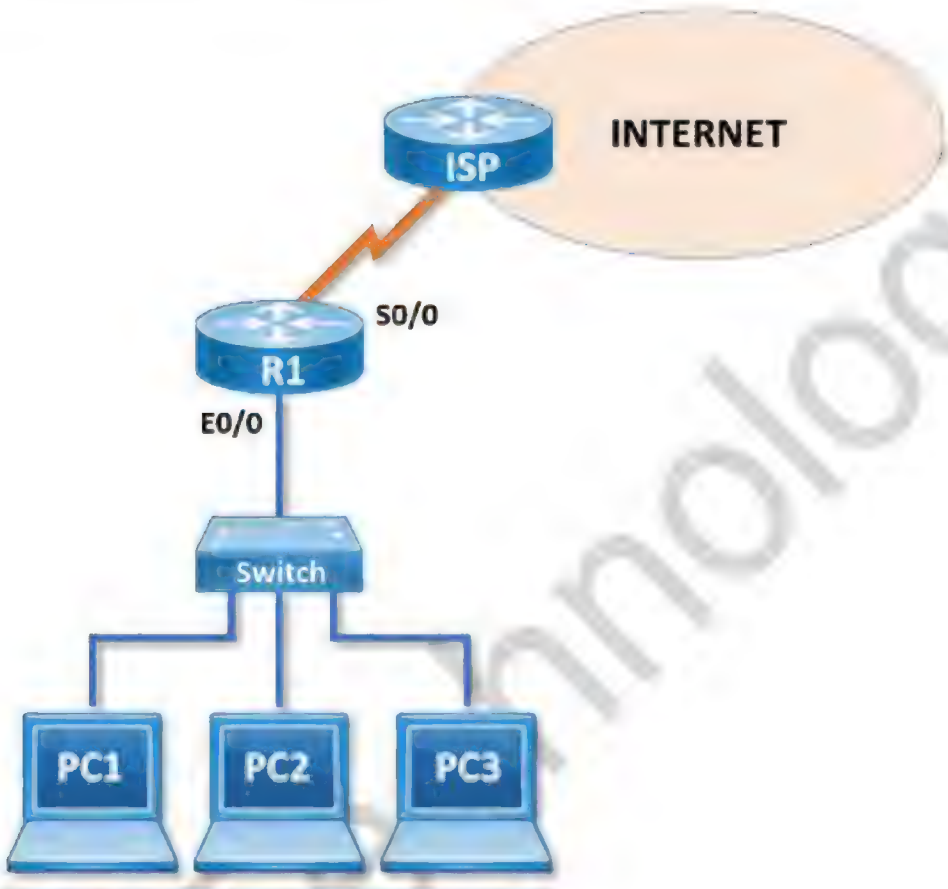
LAB 22: PORT ADDRESS TRANSLATION (PAT)

OBJECTIVE:

To configure PAT for LAN computers to access the Internet using a single Public IP Address.

TOPOLOGY:

Setup Ethernet and Serial connectivity for the lab as below :



Interface	IP Address / Mask
E0/0	192.168.2.1/24
S0/0	202.1.0.18/29

Pre-requisite: Default Routing configuration to be done on the router (LAB – 19)

TASK:

- Configure PAT
- Verify PAT

Configure PAT

R1 (config) # **interface serial 0/0**
R1 (config-if) # **ip nat outside**
R1 (config-if) # **exit**
R1 (config) # **interface ethernet 0/0**
R1 (config-if) # **ip nat inside**
R1 (config-if) # **exit**
R1 (config) # **access-list 10 permit 192.168.2.0 0.0.0.255**
R1 (config) # **ip nat inside source list 10 interface serial 0/0 overload**

Verify PAT

R1 – Verification

R1 # **show ip nat translation**

Pro	Inside global	Inside local	Outside local	Outside global
icmp	202.1.0.18:34071	192.168.2.10:34071	202.2.0.17:34071	202.2.0.17:34071
tcp	202.1.0.18:49237	192.168.2.10:49237	202.2.0.17:80	202.2.0.17:80

R1 #

Verification from PC1

ping 202.2.0.17

PING 202.2.0.17 (202.2.0.17) 56(84) bytes of data.
64 bytes from 202.2.0.17: icmp_seq=1 ttl=62 time=24.0 ms
64 bytes from 202.2.0.17: icmp_seq=2 ttl=62 time=24.0 ms
64 bytes from 202.2.0.17: icmp_seq=3 ttl=62 time=24.1 ms
64 bytes from 202.2.0.17: icmp_seq=4 ttl=62 time=24.0 ms

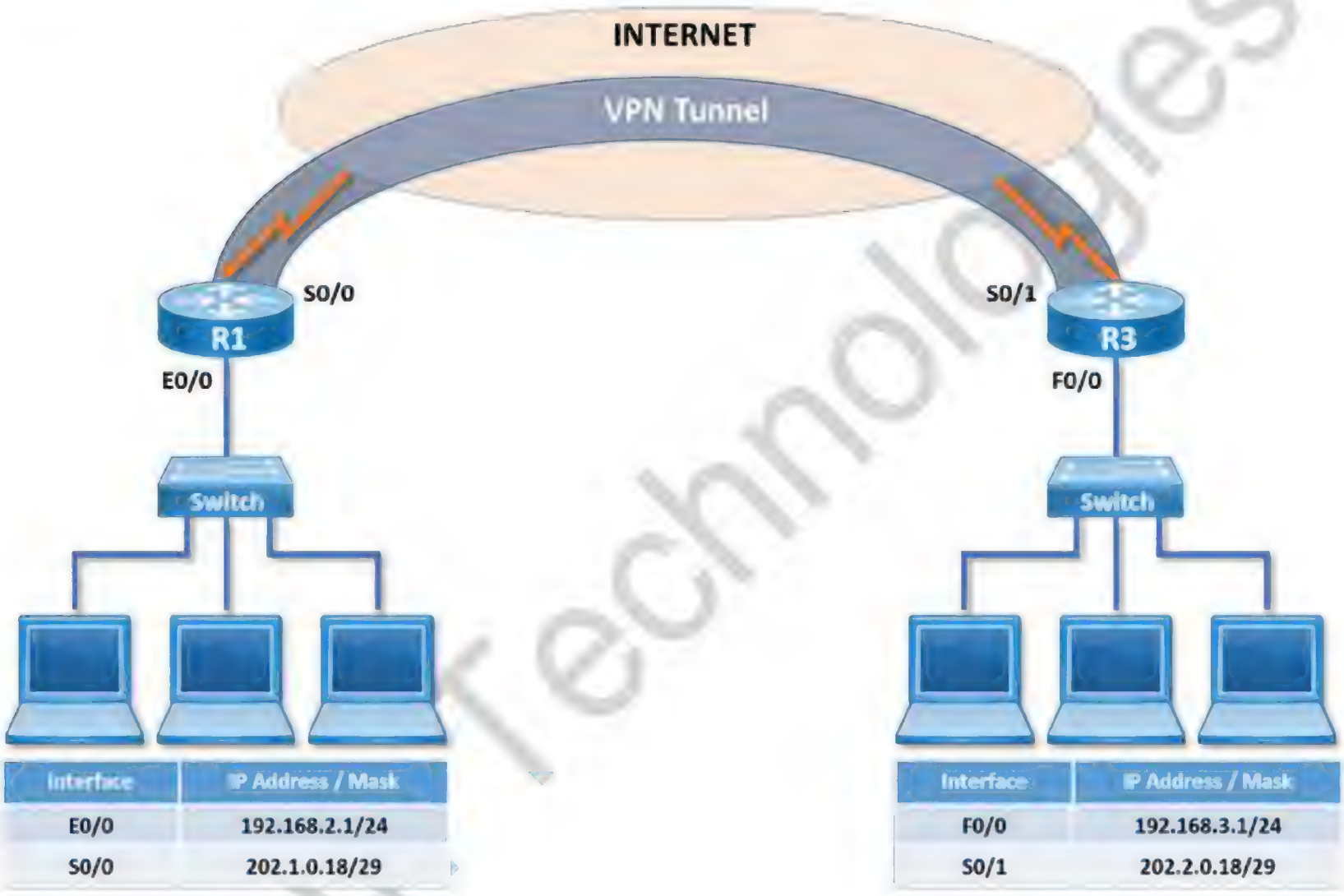
LAB 23: GENERIC ROUTING ENCAPSULATION (GRE)

OBJECTIVE:

To set up a GRE VPN to enable communication between different networks .

TOPOLOGY:

Setup Ethernet and Serial connectivity for the lab as below :



Interface	IP Address / Mask
E0/0	192.168.2.1/24
S0/0	202.1.0.18/29

Interface	IP Address / Mask
F0/0	192.168.3.1/24
S0/1	202.2.0.18/29

TASK:

- Configure Serial Interface
- Configure Default Routing
- Configure GRE Tunnel Interface
- Verify GRE Tunnel Configuration
- Configure Routing
- Verify Routing
- Verify communication between the networks

Configure Serial Interface

R1 – Configuration

R1 (config) # **interface serial 0/0**
R1 (config-if) # **ip address 202.1.0.18 255.255.255.248**
R1 (config-if) # **no shutdown**
R1 (config-if) # **encapsulation ppp**
R1 (config-if) # **exit**
R1 (config) #

R3 – Configuration

R3 (config) # **interface serial 0/1**
R3 (config-if) # **ip address 202.2.0.18 255.255.255.248**
R3 (config-if) # **no shutdown**
R3 (config-if) # **encapsulation ppp**
R3 (config-if) # **exit**
R3 (config) #

Configure Default Routing

R1 – Configuration

R1 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R1 (config) # **ip route 0.0.0.0 0.0.0.0 Serial0/0**
R1 (config) # **exit**
R1 #

R3 – Configuration

R3 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R3 (config) # **ip route 0.0.0.0 0.0.0.0 Serial0/1**
R3 (config) # **exit**
R3 #

Configure GRE Tunnel Interface

R1 – Configuration

R1 (config) # **int tunnel 0**
R1 (config-if)# **ip add 1.1.1.1 255.255.255.0**
R1 (config-if)# **tunnel source serial 0/0**
R1 (config-if)# **tunnel destination 202.2.0.18**
R1 (config-if)# **^Z**
R1 #

R3 – Configuration

R3 (config) # **int tunnel 0**
R3 (config-if)# **ip add 1.1.1.2 255.255.255.0**
R3 (config-if)# **tunnel source serial 0/1**
R3 (config-if)# **tunnel destination 202.1.0.18**
R3 (config-if)# **^Z**
R3 #

Verify GRE Tunnel Configuration

R1 – Verification

R1 # **sh int tunnel 0**
Tunnel0 is up, line protocol is down
  Hardware is Tunnel
Internet address is 1.1.1.1/24
  MTU 1514 bytes, BW 9 Kbit, DLY 500000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
Encapsulation TUNNEL, loopback not set
  Keepalive set (10 sec)
Tunnel source 202.1.0.18 (Serial0/0), destination 202.2.0.18
  Tunnel protocol/transport GRE/IP, key disabled, sequencing disabled
  Checksumming of packets disabled, fast tunneling enabled
  !
<output omitted>
  !
R1#

R3 – Verification

R3 # **sh int tunnel 0**
Tunnel0 is up, line protocol is down
  Hardware is Tunnel
Internet address is 1.1.1.2/24
  MTU 1514 bytes, BW 9 Kbit, DLY 500000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
Encapsulation TUNNEL, loopback not set
  Keepalive set (10 sec)
Tunnel source 202.2.0.18 (Serial0/1), destination 202.1.0.18
  Tunnel protocol/transport GRE/IP, key disabled, sequencing disabled
  Checksumming of packets disabled, fast tunneling enabled
  !
<output omitted>
  !
R3 #

Configure Routing

R1 – Configuration

R1 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R1 (config) # **ip route 192.168.3.0 255.255.255.0 tunnel 0**
R1 (config) #

R3 – Configuration

R3 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R3 (config) # **ip routing**
R1 (config) # **ip route 192.168.2.0 255.255.255.0 tunnel 0**
R3 (config) #

Verify Routing

R1 – Verification:

R1 # **show ip route**
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
* - candidate default, U - per-user static route, o - ODR
P - periodic downloaded static route

Gateway of last resort is not set

C 172.16.0.0/16 is directly connected, Serial0/0
C 192.168.2.0/24 is directly connected, Ethernet0/0
S 192.168.3.0/24 [1/0] directly connected, Tunnel0
S* 0.0.0.0/0 [1/0] via Serial0/0

R1 #

R3 – Verification:

R3 # **show ip route**
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
* - candidate default, U - per-user static route, o - ODR
P - periodic downloaded static route

Gateway of last resort is not set

C 172.16.0.0/16 is directly connected, Serial0/1
C 192.168.3.0/24 is directly connected, FastEthernet0/0
S 192.168.2.0/24 [1/0] directly connected, Tunnel0
S* 0.0.0.0/0 [1/0] via Serial0/1

R3 #

Verify communication between the networks

Verification from a Computer in R1 Network by pinging a computer in the R3 network

ping 192.168.3.10

PING 192.168.3.10 (192.168.3.10) 56(84) bytes of data.
64 bytes from 192.168.3.10: icmp_seq=25 ttl=62 time=24.1 ms
64 bytes from 192.168.3.10: icmp_seq=26 ttl=62 time=24.1 ms
64 bytes from 192.168.3.10: icmp_seq=27 ttl=62 time=24.3 ms
64 bytes from 192.168.3.10: icmp_seq=28 ttl=62 time=24.2 ms
64 bytes from 192.168.3.10: icmp_seq=29 ttl=62 time=24.2 ms

Verification from a Computer in R3 Network by pinging a computer in the R1 network

ping 192.168.2.10

PING 192.168.2.10 (192.168.2.10) 56(84) bytes of data.
64 bytes from 192.168.2.10: icmp_seq=25 ttl=62 time=24.1 ms
64 bytes from 192.168.2.10: icmp_seq=26 ttl=62 time=24.1 ms
64 bytes from 192.168.2.10: icmp_seq=27 ttl=62 time=24.3 ms
64 bytes from 192.168.2.10: icmp_seq=28 ttl=62 time=24.2 ms
64 bytes from 192.168.2.10: icmp_seq=29 ttl=62 time=24.2 ms

LAB 24: Hot Standby Router Protocol (HSRP)

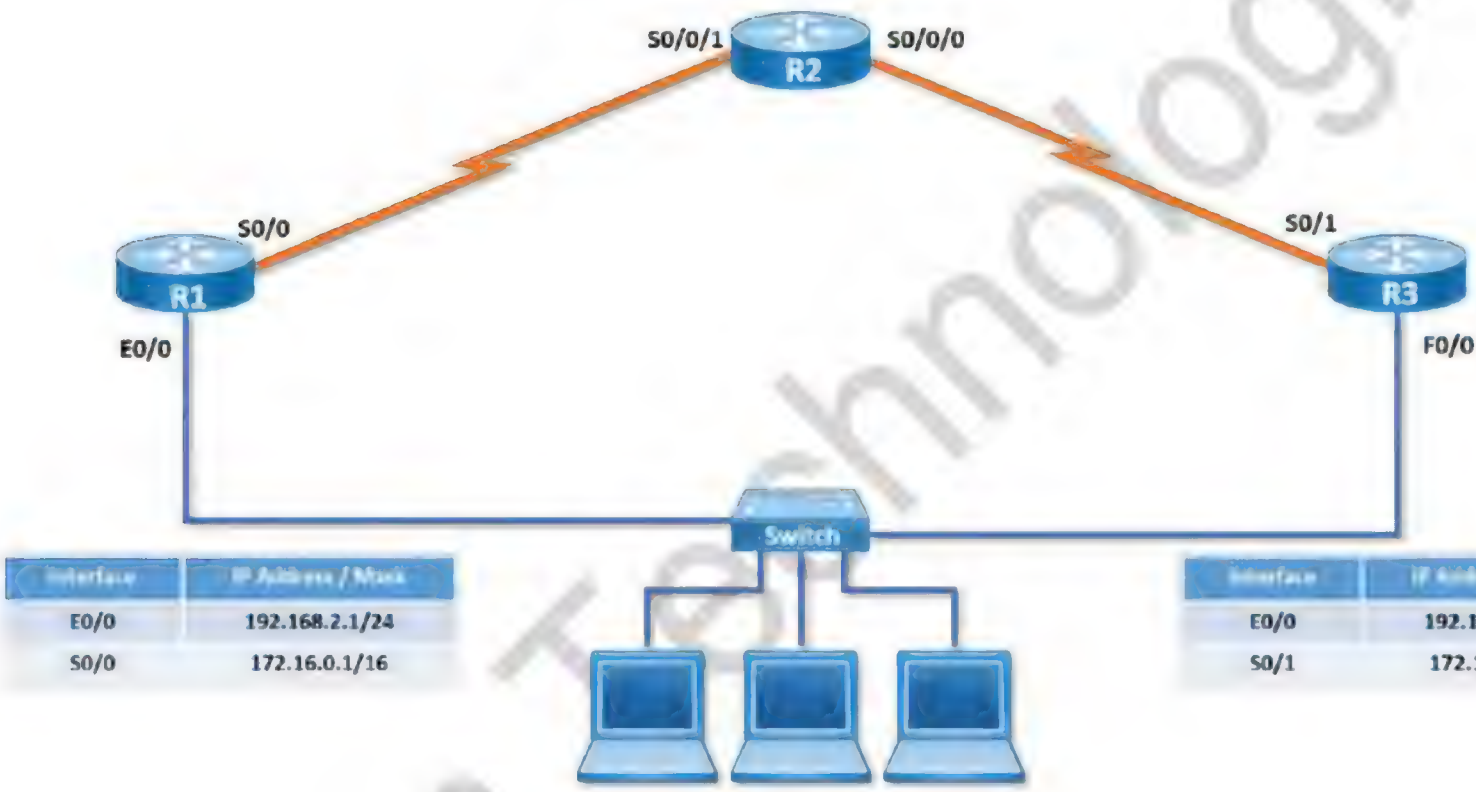
OBJECTIVE:

To set up an always available gateway by configuring HSRP

To set up a virtual default gateway with IP 192.168.2.100 for setting up HSRP

TOPOLOGY:

Setup Serial and Ethernet connectivity for the lab as below:



Interface	IP Address / Mask
E0/0	192.168.2.1/24
S0/0	172.16.0.1/16

Interface	IP Address / Mask
E0/0	192.168.2.2/24
S0/1	172.17.0.2/16

- Configure HSRP
- Verify HSRP Configuration

Configure HSRP

R1 – Configuration

R1 (config) # **int Ethernet 0/0**
R1 (config-if) # **standby 1 ip 192.168.2.100**
R1 (config-if) # **standby 1 preempt**
R1(config-if) # **^Z**
R1 #

R3 – Configuration

R3 (config) # **int FastEthernet 0/0**
R3 (config-if) # **standby 1 ip 192.168.2.100**
R3 (config-if) # **standby 1 preempt**
R3 (config-if) # **^Z**
R3 #

Verify HSRP Configuration

R1 – Verification

R1 # **show standby**
Ethernet0/0 - Group 1
Local state is Standby, priority 100, may preempt
  Hellotime 3 holdtime 10
  Next hello sent in 00:00:01.123
  Hot standby IP address is 192.168.2.100 configured
Active router is 192.168.2.2 expires in 00:00:07, priority 100
Standby router is local
  1 state changes, last state change 00:00:01
R1#

R3 – Verification

R3 # **show standby**
FastEthernet0/0 - Group 1
State is Active
   2 state changes, last state change 00:00:11
Virtual IP address is 192.168.2.100
  Active virtual MAC address is 0000.0c07.ac01
    Local virtual MAC address is 0000.0c07.ac01 (v1 default)
  Hello time 3 sec, hold time 10 sec
    Next hello sent in 0.324 secs
Preemption enabled
Active router is local
Standby router is 192.168.2.1, priority 100 (expires in 8.017 sec)
Priority 100 (default 100)
  IP redundancy name is "hsrp-Fa0/0-1" (default)
R3#

Verify communication and data path to destination network

From 192.168.3.1 computer (i.e. PC1)

ping 192.168.3.1

Pinging 192.168.3.1 with 32 bytes of data:
Reply from 192.168.3.1: bytes=32 time=19ms TTL=254
Reply from 192.168.3.1: bytes=32 time=18ms TTL=254
Reply from 192.168.3.1: bytes=32 time=18ms TTL=254
Reply from 192.168.3.1: bytes=32 time=18ms TTL=254

tracert 192.168.3.1

Tracing route to 192.168.3.1 over a maximum of 30 hops

```
1    1 ms    1 ms    1 ms  192.168.2.2
 2   26 ms   26 ms   26 ms  192.168.3.1
```

Trace complete.

Understand HSRP behaviour

Currently data is flowing via R3 router, if R3 router goes down data will start flowing through. R1 router.

You can verify the behaviour by shutting down R3 Router Ethernet Interface (LAN Interface) and again verify communication and data path to destination network from the LAN.

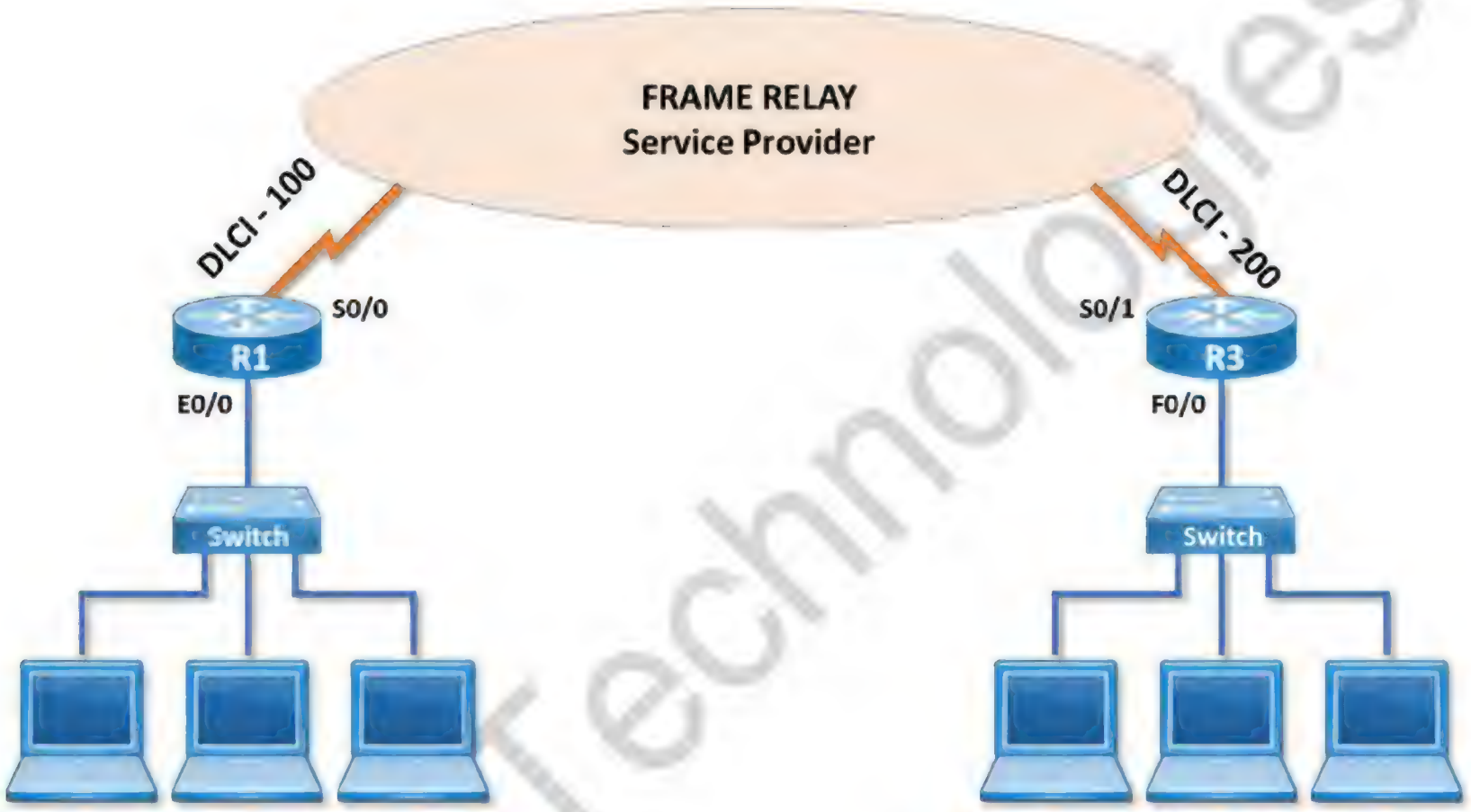
LAB 25: FRAME RELAY

OBJECTIVE:

To set up a frame relay PVC to enable communication between different networks.

TOPOLOGY:

Setup Ethernet and Serial connectivity for the lab as below:



Interface	IP Address / Mask
E0/0	192.168.2.1/24
S0/0	172.16.0.1/16

Interface	IP Address / Mask
F0/0	192.168.3.1/24
S0/1	172.16.0.2/16

TASK:

- Configure Frame relay
- Verify Frame relay configuration
- Troubleshoot Frame relay configuration
- Configure Routing
- Verify Routing
- Verify communication between the networks

Configure Frame relay

R1 – Configuration

R1(config)#**interface serial 0/0**
R1(config-if)#**ip address 172.16.0.1 255.255.0.0**
R1(config-if)#**no shutdown**
R1(config-if)#**encapsulation frame-relay**
R1(config-if)#**frame-relay lmi-type cisco**
R1(config-if)#**frame-relay interface-dlci 100**
R1(config-fr-dlci)#**exit**
R1(config-if)#**^Z**
R1#

R3 – Configuration

R3 (config) # **interface serial 0/1**
R3 (config-if) # **ip address 172.16.0.2 255.255.0.0**
R3 (config-if) # **no shutdown**
R3 (config-if) # **encapsulation frame-relay**
R3 (config-if) # **frame-relay lmi-type cisco**
R3 (config-if) # **frame-relay interface-dlci 200**
R3 (config-fr-dlci) # **exit**
R3 (config-if) # **^Z**
R3 #

Verify Frame relay configuration

R1 – Verification

R1#**show frame-relay pvc**

PVC Statistics for interface Serial0/0 (Frame Relay DTE)

	Active	Inactive	Deleted	Static
Local	1	0	0	0
Switched	0	0	0	0
Unused	0	0	0	0

DLCI = 100, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial0/0

input pkts 1 output pkts 1 in bytes 34
out bytes 34 dropped pkts 0 in FECN pkts 0
in BECN pkts 0 out FECN pkts 0 out BECN pkts 0
in DE pkts 0 out DE pkts 0
out bcast pkts 1 out bcast bytes 34
pvc create time 00:06:49, last time pvc status changed 00:01:21
R1#

R1#**show frame-relay map**
Serial0/0 (up): ip 172.16.0.2 dlci 100(0x64,0x1840), dynamic,
broadcast,, status defined, active
R1 #

R3 – Verification

R3#**show frame-relay pvc**

PVC Statistics for interface Serial0/1 (Frame Relay DTE)

	Active	Inactive	Deleted	Static
Local	1	0	0	0
Switched	0	0	0	0
Unused	0	0	0	0

DLCI = 200, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial0/1

input pkts 1 output pkts 1 in bytes 34
out bytes 34 dropped pkts 0 in pkts dropped 0
out pkts dropped 0 out bytes dropped 0
in FECN pkts 0 in BECN pkts 0 out FECN pkts 0
out BECN pkts 0 in DE pkts 0 out DE pkts 0
out bcast pkts 1 out bcast bytes 34
pvc create time 00:03:14, last time pvc status changed 00:03:14
R3#

R3#**show frame-relay map**
Serial0/1 (up): ip 172.16.0.1 dlci 200(0xC8,0x3080), dynamic,
broadcast,, status defined, active
R3 #

Troubleshooting Frame relay Configuration

There are can be 3 different states of the PVC :

1. **PVC STATUS = ACTIVE**

   (Connectivity and configuration is fine)

2. **PVC STATUS = INACTIVE ,**

   (Connectivity and configuration problem at remote end)

3. **PVC STATUS = DELETED,**

   (Connectivity or configuration problem locally)

Configure Routing

R1 – Configuration

R1 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R1 (config) # **ip routing**
R1 (config) # **router eigrp 10**
R1 (config-router) # **network 192.168.2.0**
R1 (config-router) # **network 172.16.0.0**
R1 (config-router) # **end**
R1 (config) #

R3 – Configuration

R3 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R3 (config) # **ip routing**
R3 (config) # **router eigrp 10**
R3 (config-router) # **network 192.168.3.0**
R3 (config-router) # **network 172.16.0.0**
R3 (config-router) # **end**
R3 (config) #

Verify Routing

R1 – Verification:

R1 # **show ip route**
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
* - candidate default, U - per-user static route, o - ODR
P - periodic downloaded static route

Gateway of last resort is not set

C 172.16.0.0/16 is directly connected, Serial0/0
C 192.168.2.0/24 is directly connected, Ethernet0/0
D 192.168.3.0/24 [90/2172416] via 172.16.0.2, 00:03:08, Serial0/0
R1 #

R3 – Verification:

R3 # **show ip route**
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
* - candidate default, U - per-user static route, o - ODR
P - periodic downloaded static route

Gateway of last resort is not set

C 172.16.0.0/16 is directly connected, Serial0/1
D 192.168.2.0/24 [90/2195456] via 172.16.0.1, 00:03:33, Serial0/1
C 192.168.3.0/24 is directly connected, FastEthernet0/0
R3 #

Verify communication between the networks

Verification from a Computer in R1 Network by pinging a computer in the R3 network

ping 192.168.3.10

PING 192.168.3.10 (192.168.3.10) 56(84) bytes of data.
64 bytes from 192.168.3.10: icmp_seq=25 ttl=62 time=24.1 ms
64 bytes from 192.168.3.10: icmp_seq=26 ttl=62 time=24.1 ms
64 bytes from 192.168.3.10: icmp_seq=27 ttl=62 time=24.3 ms
64 bytes from 192.168.3.10: icmp_seq=28 ttl=62 time=24.2 ms
64 bytes from 192.168.3.10: icmp_seq=29 ttl=62 time=24.2 ms

Verification from a Computer in R3 Network by pinging a computer in the R1network

ping 192.168.2.10

PING 192.168.2.10 (192.168.2.10) 56(84) bytes of data.
64 bytes from 192.168.2.10: icmp_seq=25 ttl=62 time=24.1 ms
64 bytes from 192.168.2.10: icmp_seq=26 ttl=62 time=24.1 ms
64 bytes from 192.168.2.10: icmp_seq=27 ttl=62 time=24.3 ms
64 bytes from 192.168.2.10: icmp_seq=28 ttl=62 time=24.2 ms
64 bytes from 192.168.2.10: icmp_seq=29 ttl=62 time=24.2 ms

LAB 26: IPv6

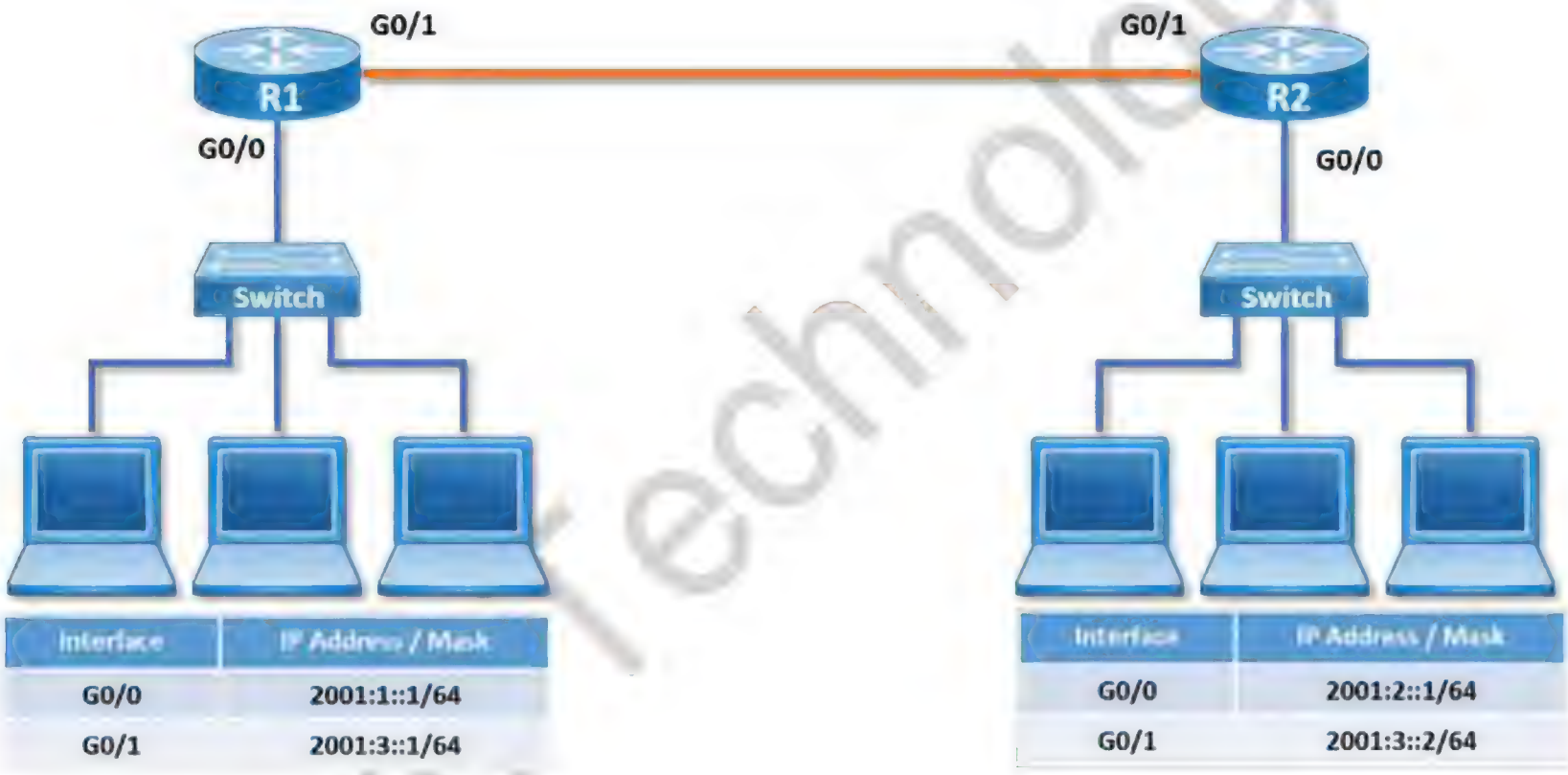
OBJECTIVE:

To configure Ipv6 address on router Interfaces

To configure Ipv6 routing (OSPF, EIGRP and Static routing) for enabling communication between different networks connected to different routers.

TOPOLOGY:

Setup the lab as below:



Interface	IP Address / Mask
G0/0	2001:1::1/64
G0/1	2001:3::1/64

Interface	IP Address / Mask
G0/0	2001:2::1/64
G0/1	2001:3::2/64

TASK:

- Configure IPV6 addresses on the router interfaces
- Verify IPv6 Routing Table
- Configure OSPF v3 routing
- Verify OSPF v3 routing
- Verify communication between the networks
- Configure EIGRP v6 routing
- Verify EIGRP v6 routing
- Configure Static Routing
- Verify Static Routing

Configure IPV6 addresses on the router interfaces

R1 – Configuration

R1 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.

R1 (config) # **int Gi0/0**
R1 (config-if) # **ipv6 address 2001::1/64**
R1 (config-if) # **no shutdown**
R1 (config-if) # **exit**
R1 (config) # **interface Gi0/1**
R1 (config-if) # **ipv6 address 2001:3::1/64**
R1 (config-if) # **no shutdown**
R1 (config-if) # **exit**

R2 – Configuration

R2 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R2 (config) # **interface Gi0/0**
R2 (config-if) # **ipv6 address 2001:2::1/64**
R2 (config-if) # **no shutdown**
R2 (config-if) # **exit**
R2 (config) # **interface Gi0/1**
R2 (config-if) # **ipv6 address 2001:3::2/64**
R2 (config-if) # **no shutdown**
R2 (config-if) # **exit**

R1 – Verification

R1 # **show ipv6 interface brief**
GigabitEthernet0/0 [up/up]
FE80::213:C4FF:FEDD:CF00
2001:1::1
GigabitEthernet0/1 [up/up]
FE80::213:C4FF:FEDD:CF01
2001:3::1

R2 – Verification

R2 # **show ipv6 interface brief**
GigabitEthernet0/0 [up/up]
FE80::214:1CFF:FECA:3EB0
2001:2::1
GigabitEthernet0/1 [up/up]
FE80::214:1CFF:FECA:3EB1
2001:3::2

Note: By default, when ipv6 routing is enabled, the directly connected networks are automatically added into the routing information table. **"C"** represents directly connected networks.

Verify IPv6 Routing Table

R1 – Verification:

```
R1 # show ipv6 route
IPv6 Routing Table - default - 5 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, HA - Home Agent, MR - Mobile Router, R - RIP
       I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary
       D - EIGRP, EX - EIGRP external, NM - NEMO, ND - Neighbor Discovery
       O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
C   2001:1::/64 [0/0]
     via GigabitEthernet0/0, directly connected
L   2001:1::1/128 [0/0]
     via GigabitEthernet0/0, receive
C   2001:3::/64 [0/0]
     via GigabitEthernet0/1, directly connected
L   2001:3::1/128 [0/0]
     via GigabitEthernet0/1, receive
L   FF00::/8 [0/0]
     via Null0, receive
R1 #
```

R2 – Verification:

```
R2 # show ipv6 route
IPv6 Routing Table - default - 5 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, HA - Home Agent, MR - Mobile Router, R - RIP
       I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary
       D - EIGRP, EX - EIGRP external, NM - NEMO, ND - Neighbor Discovery
       O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
C   2001:2::/64 [0/0]
     via GigabitEthernet0/0, directly connected
L   2001:2::1/128 [0/0]
     via GigabitEthernet0/0, receive
C   2001:3::/64 [0/0]
     via GigabitEthernet0/1, directly connected
L   2001:3::2/128 [0/0]
     via GigabitEthernet0/1, receive
L   FF00::/8 [0/0]
     via Null0, receive
```

R2 #

Configure OSPF v3 routing

R1 – Configuration

R1 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R1 (config) # **ipv6 unicast-routing**
R1 (config) # **ipv6 router ospf 1**
R1 (config-router) # **router-id 1.1.1.1**
R1 (config-router) # **exit**

R1 (config) # **interface Gi0/0**
R1 (config-if) # **ipv6 ospf 1 area 0**
R1 (config-if) # **exit**
R1 (config) # **interface Gi0/1**
R1 (config-if) # **ipv6 ospf 1 area 0**
R1 (config-if) # **exit**
R1 (config) # **exit**

R2 – Configuration

R2 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R2 (config) # **ipv6 unicast-routing**
R2 (config) # **ipv6 router ospf 2**
R2 (config-router) # **router-id 2.2.2.2**
R2 (config-router) # **exit**

R2 (config) # **interface Gi0/0**
R2 (config-if) # **ipv6 ospf 2 area 0**
R2 (config-if) # **exit**
R2 (config) # **interface Gi0/1**
R2(config-if) # **ipv6 ospf 2 area 0**
R2 (config-if) # **exit**
R2 (config) # **exit**

Verify OSPF v3 routing

Once OSPF routing is enabled, IP Networks learnt via **OSPF** are added into the routing table. **"O"** represents **OSPF route.**

R1 – Verification:

R1 # **show ipv6 route**
IPv6 Routing Table - default - 6 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
B - BGP, HA - Home Agent, MR - Mobile Router, R - RIP
I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary
D - EIGRP, EX - EIGRP external, NM - NEMO, ND - Neighbor Discovery

```
     O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
     ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
C   2001:1::/64 [0/0]
     via GigabitEthernet0/0, directly connected
L   2001:1::1/128 [0/0]
     via GigabitEthernet0/0, receive
O   2001:2::/64 [110/1]
     via GigabitEthernet0/0, directly connected
C   2001:3::/64 [0/0]
     via GigabitEthernet0/1, directly connected
L   2001:3::1/128 [0/0]
     via GigabitEthernet0/1, receive
L   FF00::/8 [0/0]
     via Null0, receive
R1 #
```

R2 – Verification:

R2 # **show ip route**

```
IPv6 Routing Table - default - 6 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
     B - BGP, HA - Home Agent, MR - Mobile Router, R - RIP
     I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary
     D - EIGRP, EX - EIGRP external, NM - NEMO, ND - Neighbor Discovery
     O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext
     ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
O   2001:1::/64 [110/1]
     via GigabitEthernet0/0, directly connected
C   2001:2::/64 [0/0]
     via GigabitEthernet0/0, directly connected
L   2001:2::1/128 [0/0]
     via GigabitEthernet0/0, receive
C   2001:3::/64 [0/0]
     via GigabitEthernet0/1, directly connected
L   2001:3::2/128 [0/0]
     via GigabitEthernet0/1, receive
L   FF00::/8 [0/0]
     via Null0, receive
R2 #
```

Verify communication between the networks

Verification from a Computer in R1 Network

ping 2001:2::10

```
Pinging 2001:2::10 with 32 bytes of data:
Reply from 2001:2::10: time<1ms
Reply from 2001:2::10: time<1ms
```

Reply from 2001:2::10: time<1ms
Reply from 2001:2::10: time<1ms

Verification from a Computer in R2 Network

ping 2001:1::10

Pinging 2001:1::10 with 32 bytes of data:
Reply from 2001:1::10: time<1ms
Reply from 2001:1::10: time<1ms
Reply from 2001:1::10: time<1ms
Reply from 2001:1::10: time<1ms

Configure EIGRP v6 routing

R1 – Configuration

R1 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R1 (config) # **ipv6 unicast-routing**
R1 (config) # **ipv6 router eigrp 10**
R1 (config-router) # **router-id 1.1.1.1**
R1 (config-router) # **exit**

R1 (config) # **interface Gi0/0**
R1 (config-if) # **ipv6 eigrp 10**
R1 (config-if) # **exit**
R1 (config) # **interface Gi0/1**
R1 (config-if) # **ipv6 eigrp 10**
R1 (config-if) # **exit**
R1 (config) # **exit**

R2 – Configuration

R2 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R2 (config) # **ipv6 unicast-routing**
R2 (config) # **ipv6 router eigrp 10**
R2 (config-router) # **router-id 2.2.2.2**
R2 (config-router) # **exit**

R2 (config) # **interface Gi0/0**
R2 (config-if) # **ipv6 eigrp 10**
R2 (config-if) # **exit**
R2 (config) # **interface Gi0/1**
R2(config-if) # **ipv6 eigrp 10**
R2 (config-if) # **exit**
R2 (config) # **exit**

Verify EIGRP v6 routing

Once EIGRP routing is enabled, IP Networks learned through **EIGRP** are added into the routing information table. **"D"** represents **EIGRP route.**

R1 – Verification:

R1 # **show ipv6 route**
IPv6 Routing Table - default - 6 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
B - BGP, HA - Home Agent, MR - Mobile Router, R - RIP
I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary
D - EIGRP, EX - EIGRP external, NM - NEMO, ND - Neighbor Discovery
O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
C 2001:1::/64 [0/0]
via GigabitEthernet0/0, directly connected
L 2001:1::1/128 [0/0]
via GigabitEthernet0/0, receive
D 2001:2::/64 [90/28416]
via FE80::214:1CFF:FECA:3EB1, GigabitEthernet0/1
C 2001:3::/64 [0/0]
via GigabitEthernet0/1, directly connected
L 2001:3::1/128 [0/0]
via GigabitEthernet0/1, receive
L FF00::/8 [0/0]
via Null0, receive
R1#

R2 – Verification:

R2 # **show ipv6 route**
IPv6 Routing Table - default - 8 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
B - BGP, HA - Home Agent, MR - Mobile Router, R - RIP
I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary
D - EIGRP, EX - EIGRP external, NM - NEMO, ND - Neighbor Discovery
O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
D 2001:1::/64 [90/28416]
via FE80::213:C4FF:FEDD:CF01, GigabitEthernet0/1
C 2001:2::/64 [0/0]
via GigabitEthernet0/0, directly connected
L 2001:2::1/128 [0/0]
via GigabitEthernet0/0, receive
C 2001:3::/64 [0/0]
via GigabitEthernet0/1, directly connected
L 2001:3::2/128 [0/0]
via GigabitEthernet0/1, receive
L FF00::/8 [0/0]

via Null0, receive
R2#

Configure Static Routing

R1 – Configuration

R1 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R1 (config) # **ipv6 route 2001:2::/64 2001:3::2**
R1 (config) # **exit**

R2 – Configuration

R2 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R2 (config) #**ipv6 route 2001:1::/64 2001:3::1**
R2 (config) # **exit**
R2 (config) #

Verify Static Routing

Once Static routing is enabled, IP Network defined through the **Static routing command** are added into the routing information table. **"S"** represents **Static route.**

R1 – Verification:

R1 # **show ipv6 route**
IPv6 Routing Table - default - 6 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
B - BGP, HA - Home Agent, MR - Mobile Router, R - RIP
I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary
D - EIGRP, EX - EIGRP external, NM - NEMO, ND - Neighbor Discovery
O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
C 2001:1::/64 [0/0]
via GigabitEthernet0/0, directly connected
L 2001:1::1/128 [0/0]
via GigabitEthernet0/0, receive
S 2001:2::/64 [1/0]
via 2001:3::2
C 2001:3::/64 [0/0]
via GigabitEthernet0/1, directly connected
L 2001:3::1/128 [0/0]
via GigabitEthernet0/1, receive
L FF00::/8 [0/0]
via Null0, receive
R1 #

R2 – Verification:

```
R2 # show ipv6 route
IPv6 Routing Table - default - 6 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, HA - Home Agent, MR - Mobile Router, R - RIP
       I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary
       D - EIGRP, EX - EIGRP external, NM - NEMO, ND - Neighbor Discovery
       O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
S   2001:1::/64 [1/0]
     via 2001:3::1
C   2001:2::/64 [0/0]
     via GigabitEthernet0/0, directly connected
L   2001:2::1/128 [0/0]
     via GigabitEthernet0/0, receive
C   2001:3::/64 [0/0]
     via GigabitEthernet0/1, directly connected
L   2001:3::2/128 [0/0]
     via GigabitEthernet0/1, receive
L   FF00::/8 [0/0]
     via Null0, receive
R2#
```

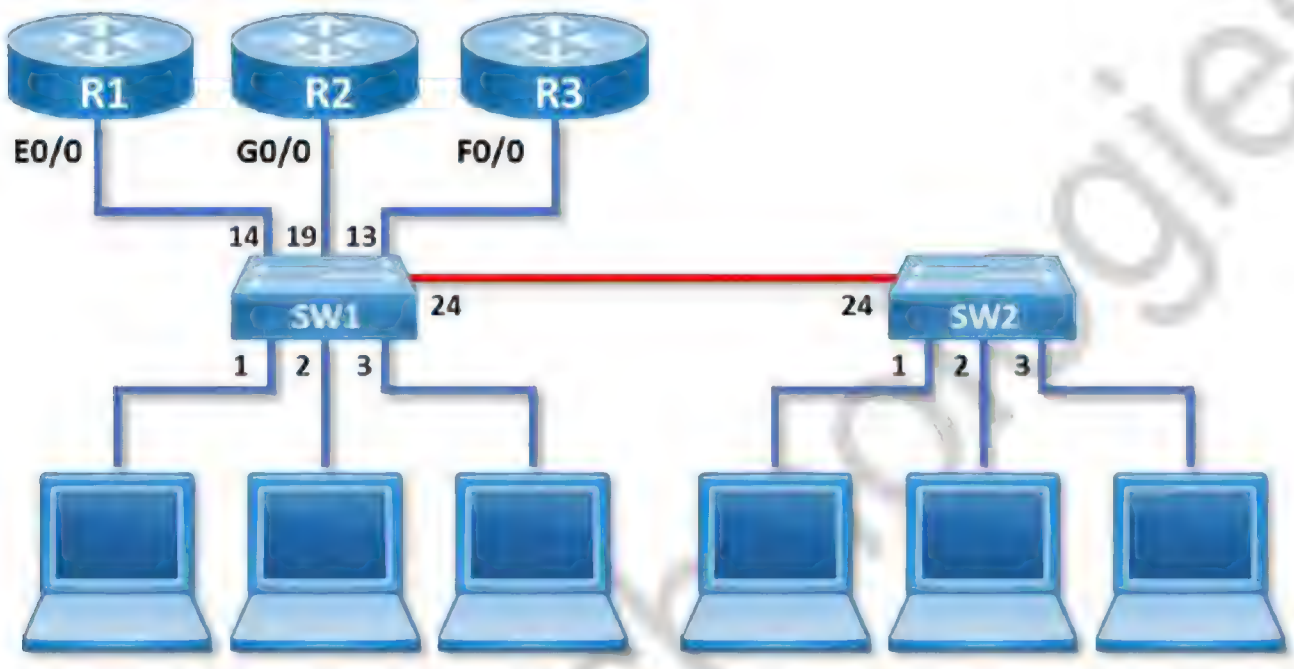
LAB 27: CISCO DISCOVERY PROTOCOL (CDP)

OBJECTIVE:

To enable CDP on routers and switches across the network for layer 2 troubleshooting.

TOPOLOGY:

Setup Switch connectivity for the lab as below:



TASK:

- Enable CDP
- Verify CDP information

Enabling CDP

SW1 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
SW1(config)# **cdp run**
SW1 #

Verify CDP information

SW1 – Verification:

SW1 # **show cdp neighbor**
Capability Codes: R - Router, T - Trans Bridge, B - Source Route Bridge
S - Switch, H - Host, I - IGMP, r - Repeater, P - Phone

Device ID	Local Intrfce	Holdtme	Capability	Platform	Port ID
SW2	Fas 0/24	127	S I	WS-C2950-2	Fas 0/24
R2	Fas 0/19	145	R S I	Cisco 2821	Gig 0/0
R3	Fas 0/13	124	R S I	Cisco 2611	Fas 0/0
R1	Fas 0/14	142	R	2610	Eth 0/0

SW1 #

SW1 # **show cdp neighbor detail**

Device ID: SW2
Entry address(es):
IP address: 192.168.20.51
Platform: cisco WS-C2950-24, Capabilities: Switch IGMP
Interface: FastEthernet0/24, Port ID (outgoing port): FastEthernet0/24
Holdtime : 167 sec

Version :
Cisco Internetwork Operating System Software
IOS (tm) C2950 Software (C2950-I6Q4L2-M), Version 12.1(13)EA1, RELEASE SOFTWARE (fc1)
Copyright (c) 1986-2003 by cisco Systems, Inc.
Compiled Tue 04-Mar-03 02:14 by yenanh

advertisement version: 2
Protocol Hello: OUI=0x00000C, Protocol ID=0x0112; payload len=27,
value=00000000FFFFFFFF010221FF0000000000000000D28F06840FF0000
VTP Management Domain: 'zoom'
Duplex: full
Management address(es):

Device ID: R2
Entry address(es):
IP address: 10.0.0.2
Platform: Cisco 2821, Capabilities: Router Switch IGMP
Interface: FastEthernet0/19, Port ID (outgoing port): GigabitEthernet0/0

Holdtime : 126 sec

Version :
Cisco IOS Software, 2800 Software (C2800NM-ADVENTERPRISEK9-M), Version 15.1(3)T2, RELEASE SOFTWARE (fc1)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2011 by Cisco Systems, Inc.
Compiled Wed 10-Aug-11 05:17 by prod_rel_team

advertisement version: 2
VTP Management Domain: ''
Duplex: full
Management address(es):

Device ID: R3
Entry address(es):
IP address: 10.0.0.3
Platform: Cisco 2611XM, Capabilities: Router Switch IGMP
Interface: FastEthernet0/13, Port ID (outgoing port): FastEthernet0/0
Holdtime : 165 sec

Version :
Cisco IOS Software, C2600 Software (C2600-ADVENTERPRISEK9-M), Version 12.4(19), RELEASE SOFTWARE (fc1)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2008 by Cisco Systems, Inc.
Compiled Fri 29-Feb-08 19:23 by prod_rel_team

advertisement version: 2
VTP Management Domain: ''
Duplex: full
Management address(es):

Device ID: R1
Entry address(es):
IP address: 10.0.0.1
Platform: cisco 2610, Capabilities: Router
Interface: FastEthernet0/14, Port ID (outgoing port): Ethernet0/0
Holdtime : 122 sec

Version :
Cisco Internetwork Operating System Software
IOS (tm) C2600 Software (C2600-IS-M), Version 12.1(4), RELEASE SOFTWARE (fc1)
Copyright (c) 1986-2000 by cisco Systems, Inc.
Compiled Wed 30-Aug-00 14:11 by cmong

advertisement version: 2
Duplex: half
Management address(es):

LAB 28: DHCP SERVER

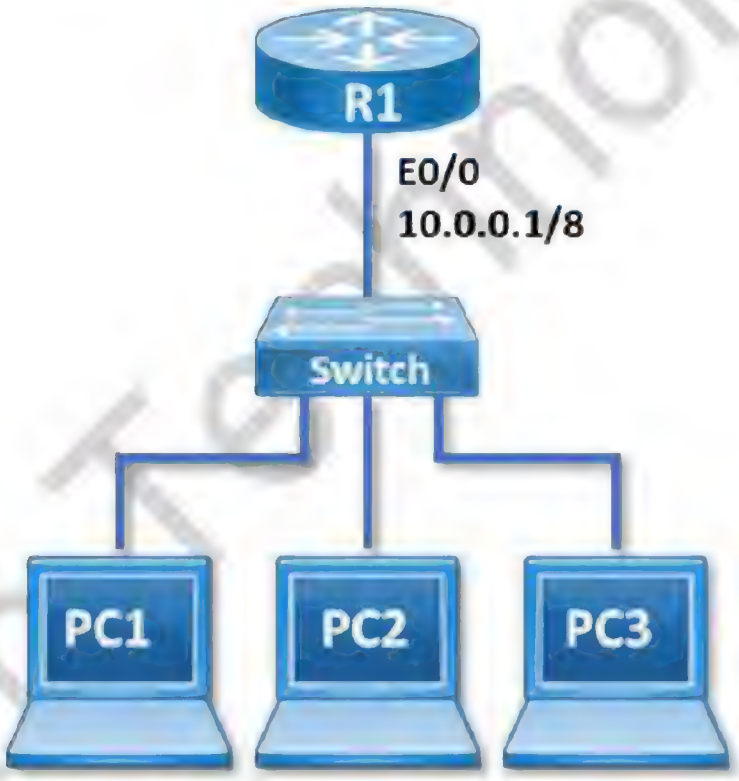
OBJECTIVE:

To configure a Router as a DHCP Server for assigning IP addresses, DNS, gateway, etc. to client computers.

To create a pool of addresses (10.0.0.0 subnet mask 255.0.0.0), set the DNS server to 8.8.8.8 ,gateway to 10.0.0.2 and exclude 10.0.0.50 and 10.0.0.100 , so that these are not alloted by the DHCP server

TOPOLOGY:

Setup the router for the lab as below:



TASK:

- Configure DHCP Server
- Verify DHCP configuration

Configure DHCP SERVER

R1 – Configuration

R1 (config) # **ip dhcp pool zoom**
R1 (dhcp-config) # **network 10.0.0.0 255.0.0.0**
R1 (dhcp-config) # **default-router 10.0.0.1**
R1 (dhcp-config) # **dns-server 8.8.8.8**
R1 (dhcp-config) # **lease 1 1 1**
R1 (dhcp-config) # **exit**
R1 (config) # **ip dhcp excluded-address 10.0.0.50 10.0.0.100**
R1 (config)# **exit**

Verify DHCP configuration

On Windows Computer, Select **Obtain IP Address Automatically** in Network Properties and verify the dhcp ip address by giving **ipconfig** command on command prompt.

On Linux Computer give below commands

 # dhclient
Internet Systems Consortium DHCP Client V3.0.6
Copyright 2004-2007 Internet Systems Consortium.
Sending on LPF/eth0/00:1b:b9:9a:16:8d
Sending on Socket/fallback
DHCPDISCOVER on eth0 to 255.255.255.255 port 67 interval 8
DHCPOFFER from 10.0.0.2
DHCPREQUEST on eth0 to 255.255.255.255 port 67
DHCPACK from 10.0.0.2
bound to 10.0.0.5 -- renewal in 40650 seconds.

 # ifconfig
eth0 Link encap:Ethernet HWaddr 00:1B:B9:9A:16:8D
inet addr:10.0.0.5 Bcast:10.255.255.255 Mask:255.0.0.0
UP BROADCAST RUNNING MULTICAST MTU:1500 Metric:1
RX packets:9263 errors:0 dropped:0 overruns:0 frame:0

R1 – Verification:

R1 # **show ip dhcp binding**
Bindings from all pools not associated with VRF:

IP address	Client-ID/ Hardware address/ User name	Lease expiration	Type
10.0.0.4	001c.c06c.91f3	Jul 27 2015 02:21 PM	Automatic
10.0.0.5	001b.b99a.168d	Jul 27 2015 02:25 PM	Automatic

R1#

LAB 29: SYSLOG

OBJECTIVE:

To configure Logging on router and sending logs to a syslog server.

TOPOLOGY:

Setup Ethernet connectivity for the lab as below :

Computer IP Address
10.0.0.11

Pre-requisite: 10.0.0.11 computer should have Syslog server software installed and running.

TASK:

- Configure logging to Syslog Server
- Configure logging to Buffer
- Generate and Verify Syslog Messages

Configure Logging to Syslog Server

R1 – Configuration

R1 (config) # **logging on**
R1 (config) # **logging host 10.0.0.11**
R1 (config) # **logging trap 7**
R1(config) #

Configure Logging to Buffer

R1 – Configuration

R1 (config) # **logging on**
R1 (config) # **logging buffered 7**
R1(config) #

Generate and Verify Syslog Messages

R1 (config) # **interface serial 0/0/0**
R1 (config-if) # **shutdown**
R1 (config-if) # **noshutdown**
R1 (config-if) # ^Z
R1 #

R1 – Verification:

R1 # **show logging**
Syslog logging: enabled (0 messages dropped, 3 messages rate-limited, 0 flushes, 0 overruns)

No Active Message Discriminator.
No Inactive Message Discriminator.
Console logging: disabled
Monitor logging: level debugging, 0 messages logged, xml disabled,
filtering disabled
Buffer logging: level debugging, 7 messages logged, xml disabled,
filtering disabled
Exception Logging: size (4096 bytes)
Count and timestamp logging messages: disabled
Persistent logging: disabled

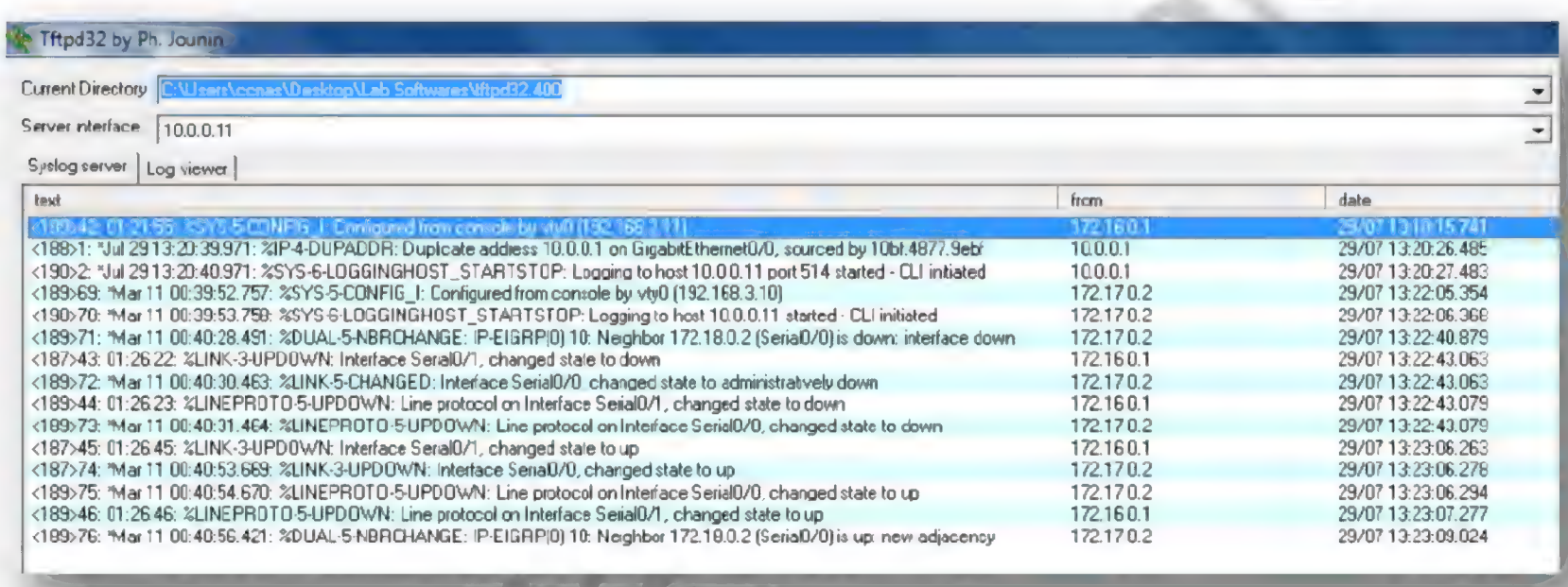
No active filter modules.
Trap logging: level informational, 45 message lines logged
Logging to 10.0.0.11 (udp port 514, audit disabled, link up),
9 message lines logged,
0 message lines rate-limited,
0 message lines dropped-by-MD,
xml disabled, sequence number disabled
filtering disabled

Log Buffer (4096 bytes):

*Jul 28 11:51:26.447: %SYS-5-CONFIG_I: Configured from console by console
*Jul 28 11:52:11.563: %LINK-5-CHANGED: Interface Serial0/0/0, changed state to administratively down
*Jul 28 11:52:11.567: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0/0, changed state to dn
*Jul 28 11:52:28.639: %SYS-5-CONFIG_I: Configured from console by console
*Jul 28 11:52:29.487: %LINK-3-UPDOWN: Interface Serial0/0/0, changed state to up
R1 #

Verification on Syslog Server (PC) :

Start **Syslog software** to view the syslog's messages as below :



LAB 30: PASSWORD RECOVERY

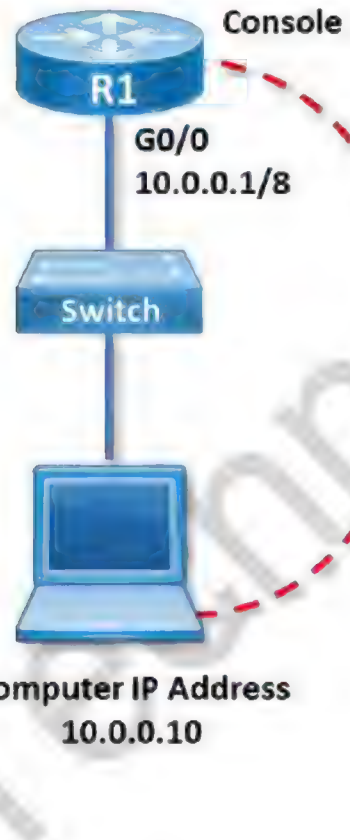
OBJECTIVE:

To get access to a router's privilegd mode in case the enable password is forgotten.

To reset the Privilege / Enable mode password of Cisco Router.

TOPOLOGY:

Setup Console and Ethernet connectivity for the lab as below:



TASK:

- Establish console connectivity
- Access router via console with an emulation software
- Enter Rom Monitor Mode and Change Register Value
- Load saved configuration to the router (i.e. NVRAM to RAM)
- Reconfigure Privilege Mode / Enable Password
- Reset the Configuration Register Value back to the default:
- Enable the Ethernet interface:
- Save configuration to the router and restart the router
- Verify login to the router using new password

Establish console connectivity

Establish console connectivity by connecting router console port to PC Com Port with console cable.

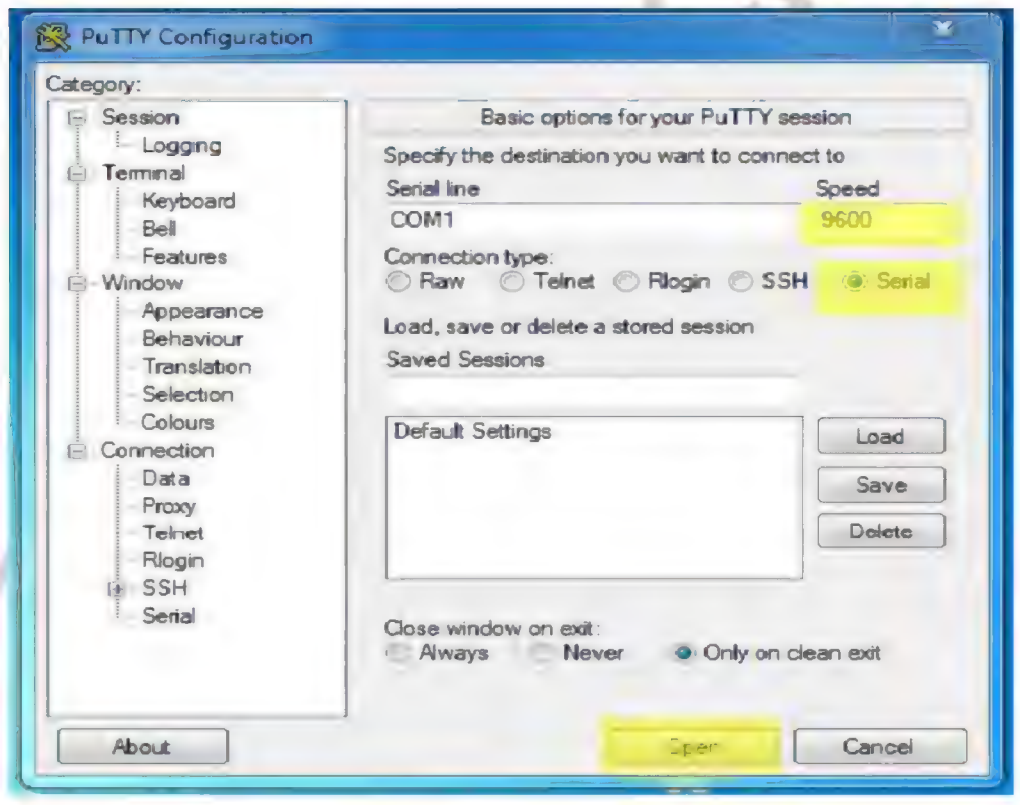
Access router via console with an emulation software

Configure the following parameters in emulation software for accessing switch via console port.

Parameters	Console Port Settings
Baud	9600
Data bits	8
Parity	None
Stop bits	1

Accessing router via console from Microsoft Windows Computer

- Start a terminal emulator application, such as **PUTTY.exe**
- Select **Serial** option and set speed to **9600.**
- Click **Open**



- Once emulation software is ready, **Power-ON** the switch.

Accessing router via console from Linux Computer

- From the terminal enter the below command
  # minicom

Enter Rom Monitor Mode and Change Configuration Register Value

Once emulation software is ready, Press **"Ctrl + Break"** within 60 sec after **POWER-ON**. Router will Enter **Rom monitor mode**.

rommon 1>

Configure Register Value 0x2142 to skip executing the startup configuration from nvram during bootup.

rommon 1 > **confreg 0x2142**
rommon 2 > **reset**

After the Router boots-up completely, it enters setup mode as below:

System Configuration Dialog
Would you like to enter the initial configuration dialog? [Yes/no]: **no**
Would you like to terminate autoinstall? [yes]: **yes**

If you choose "Yes", IOS will prompt questions to gather the information to configure the Router, it is recommended to choose "no", since we can configure the Router using IOS commands

Router >**enable**

Load saved configuration to the router

Router # **copy startup-config running-config**
Destination filename [running-config]?
R1 #

Reconfigure Privilege Mode / Enable Password

Since we are already in the privilege mode, we can setup a new privilege password.

R1 # **configure terminal**
R1 (config) # **enable secret cisco**
R1 (config) # **exit**

Reset the Configuration Register Value back to the default:

R1 (config)# **config-register 0x2102**

Enable the Ethernet interface:

R1 (config)# **interface GibaitEthernet0/0**
R1 (config-if)# **no shutdown**
IND(config-if)# **^Z**

Similarly apply the "no shutdown" command on all required interface

Saving configuration to the router and restart the router

To save configuration on router

R1 # **copy running-config startup-config**

Destination filename [startup-config]?
Building configuration...

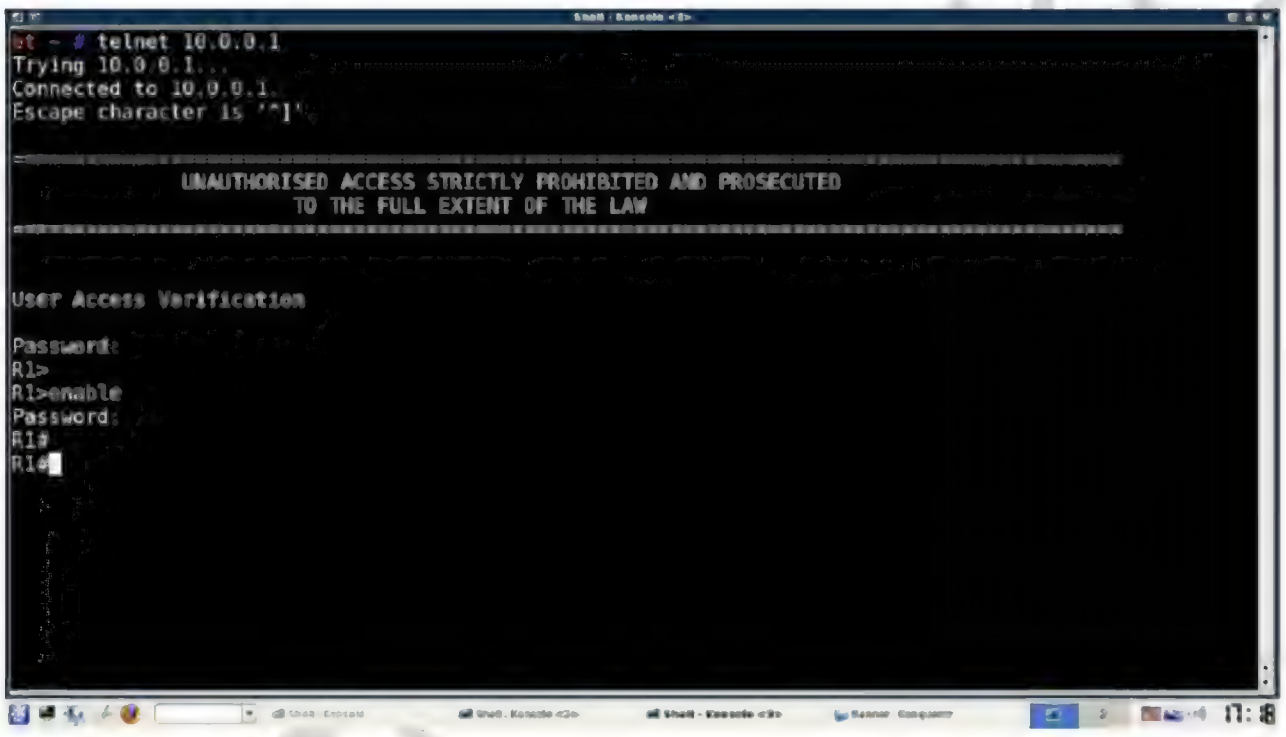
[OK]
R1 #

R1 # **reload**

Verify login to the router using new password

- Access router via telnet and Enter privilege mode using new password.

  telnet 10.0.0.1



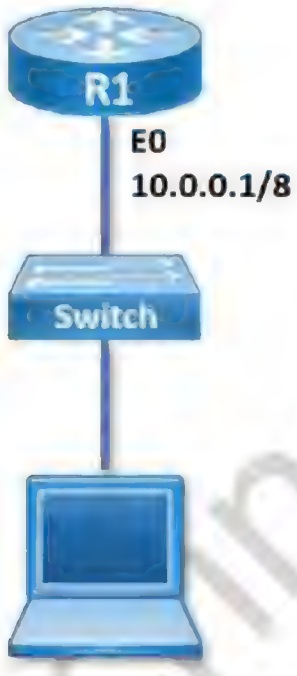
LAB 31: IOS / CONFIGURATION BACKUP

OBJECTIVE:

To take backup of the IOS and the Router Configuration

TOPOLOGY:

Setup Ethernet connectivity for the lab as below:



Computer IP Address
10.0.0.10

Pre-requisite: 10.0.0.10 computer should have TFTP server software installed and running.

TASK:

- Create a backup of Router Configuration
- Verify Configuration file on TFTP server
- Create a Backup of Router IOS
- Verify IOS file on TFTP server

Backup of Router Configuration

R1 # **copy startup-config tftp**
Address or name of remote host []? **10.0.0.10**
Destination filename [r1-confg]? **R1-start**
!!
807 bytes copied in 0.48 secs
R1 #

Verify backup configuration file on TFTP server

Verify the Configuration file on TFTP server, default path is **C:\Program Files\Cisco Systems\Cisco TFTP Server**

Backup of Router IOS

R1 # **show flash**
System flash directory:

File	Length	Name/status
1	7496864	C2800-IS-MZ_151-4.BIN

[7496928 bytes used, 9280288 available, 16777216 total]
16384K bytes of processor board System flash (Read/Write)

R1 # **copy flash tftp**
Source filename []? **C2800-IS-MZ_151-4.BIN**
Address or name of remote host []? **10.0.0.10**
Destination filename [C2800-IS-MZ_151-4.BIN]?
!!!
!!!
!!!
!!!
!!!
!!!
!!!
!!!
!!!
!!!
!!!
!!!
7496864 bytes copied in 40.254 secs (187421 bytes/sec)
R1 #

Verify backup IOS file on TFTP server

Verify the IOS file on TFTP server, default path is **C:\Program Files\Cisco Systems\Cisco TFTP Server**

LAB 32: IOS Licensing

OBJECTIVE:

To understand and install Cisco IOS license on router

TOPOLOGY:

Setup Ethernet connectivity for the lab as below:

Computer IP Address
10.0.0.10

Pre-requisite: 10.0.0.10 computer should have TFTP server software installed and running.

TASK:

- Verify Cisco IOS License
- Install License on Cisco Router

Verify Cisco IOS LIcense

```
R1 # show license
Index 1 Feature: ipbasek9
Period left: Life time
License Type: Permanent
        License State: Active, In Use
        License Count: Non-Counted
        License Priority: Medium
Index 2 Feature: securityk9
        Period left: Life time
        License Type: Permanent
        License State: Active, In Use
        License Count: Non-Counted
        License Priority: Medium
Index 3 Feature: uck9
        Period left: Not Activated
        Period Used: 0  minute  0  second
        License Type: EvalRightToUse
        License State: Not in Use, EULA not accepted
        License Count: Non-Counted
        License Priority: None
Index 4 Feature: datak9
Period left: 8  weeks 3  days
Period Used: 2  hours 44 minutes
        License Type: Evaluation
 !
<output omitted>
 !
R1 #

R1 # show license udi

Device#  PID              SN                 UDI
------------------------------------------------------------------------------------------------
*0       CISCO2911/K9     FGL161710K3        CISCO2911/K9:FGL161710K3

R1#
```

Installing License on Cisco Router

```
R1 # license install tftp:FGL161710K3.lic
Source filename []?FGL161710K3.lic
Address or name of remote host []? 10.0.0.10
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
Installing...Feature:datak9...Successful:Supported
1/1 licenses were successfully installed

R1 #
```

Note: Reload the router and verify license is installed using **show license** command.

LAB 33: PPP AUTHENTICATION

OBJECTIVE:

To enable PPP authentication between routers

TOPOLOGY:

Setup Ethernet and Serial connectivity for the lab as below:

Interface	IP Address / Mask
E0/0	192.168.2.1/24
S0/0	172.16.0.1/16

Interface	IP Address / Mask
G0/0	10.0.0.1/8
S0/0/1	172.16.0.2/16

TASK:

- Configure Serial Interface
- Verify Serial Interface Configuration
- Configure PPP Authentication (CHAP)
- Verify Serial Interface set up
- Troubleshoot PPP Authentication

Configure Serial Interface

R1 – Configuration

R1 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R1 (config)# **interface serial 0/0**
R1 (config-if)# **ip address 172.16.0.1 255.255.0.0**
R1 (config-if)# **no shutdown**
R1 (config-if)# **clock rate 64000**
R1 (config-if)# **encapsulation ppp**
R1 (config-if)# **exit**
R1 (config)#

R2 – Configuration

R2 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R2 (config)# **interface serial 0/0/1**
R2 (config-if)# **ip address 172.16.0.2 255.255.0.0**
R2 (config-if)# **no shutdown**
R2 (config-if)# **encapsulation ppp**
R2 (config-if)# **exit**
R2 (config)# **exit**

Verify Serial Interface Configuration

R1 – Verification

R1 # **show interface serial 0/0**
Serial0/0 is up, line protocol is up
  Hardware is PowerQUICC Serial
Internet address is 172.16.0.1/16
  MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
Encapsulation PPP, loopback not set
  Keepalive set (10 sec)
  LCP Open
  Open: IPCP, CDPCP
  !
<output omitted>
  !
R1 #

R2 – Verification:

R2 # **show interface serial 0/0/1**
Serial0/0/1 is up, line protocol is up
  Hardware is GT96K Serial
Internet address is 172.16.0.2/16
  MTU 1500 bytes, BW 1544 Kbit/sec, DLY 20000 usec,
    reliability 255/255, txload 1/255, rxload 1/255
Encapsulation PPP, loopback not set
  Keepalive set (10 sec)
  LCP Open
  Open: IPCP, CDPCP
  !
<output omitted>
  !
R2 #

Configure PPP Authentication (CHAP)

R1 – Configuration

R1 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R1 (config) # **username R2 password cisco**
R1 (config) # **interface serial 0/0**
R1 (config-if) # **ppp authentication chap**
R1 (config-if) # **^Z**
R1 #

R2 – Configuration

R2 # **configure terminal**
Enter configuration commands, one per line. End with CNTL/Z.
R2 (config) # **username R1 password cisco**
R2 (config) # **interface serial 0/0/1**
R2 (config-if) # **ppp authentication chap**
R2 (config-if) # **^Z**
R2 #

Verify Serial Interface

R1 – Verification

R1 # **show interface serial 0/0**
Serial0/0 is up, line protocol is up
  Hardware is PowerQUICC Serial
  Internet address is 172.16.0.1/16
  MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec,
    reliability 240/255, txload 1/255, rxload 1/255

```
Encapsulation PPP, loopback not set
  Keepalive set (10 sec)
LCP Open
Open: IPCP, CDPCP
  !
<output omitted>
  !
R1 #
```

R2 – Verification:

```
R2 # show interface serial 0/0/1
Serial0/0/1 is up, line protocol is up
  Hardware is GT96K Serial
Internet address is 172.16.0.2/16
  MTU 1500 bytes, BW 1544 Kbit/sec, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
Encapsulation PPP, loopback not set
  Keepalive set (10 sec)
LCP Open
  Open: IPCP, CDPCP
  !
<output omitted>
  !
R2 #
```

Troubleshooting PPP Authentication

After enabling PPP authentication, if you see the following output means, it means there is a problem with authentication configuration.

```
R1 # show interface serial 0/0
Serial0/0 is up, line protocol is down
  Hardware is PowerQUICC Serial
  Internet address is 172.16.0.1/16
  MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec,
     reliability 246/255, txload 1/255, rxload 1/255
Encapsulation PPP, loopback not set
  Keepalive set (10 sec)
LCP TERMsent
  Closed: IPCP, CDPCP
  !
<output omitted>
  !
R1 #
```

CHALLENGE LAB

NAT – QUESTION

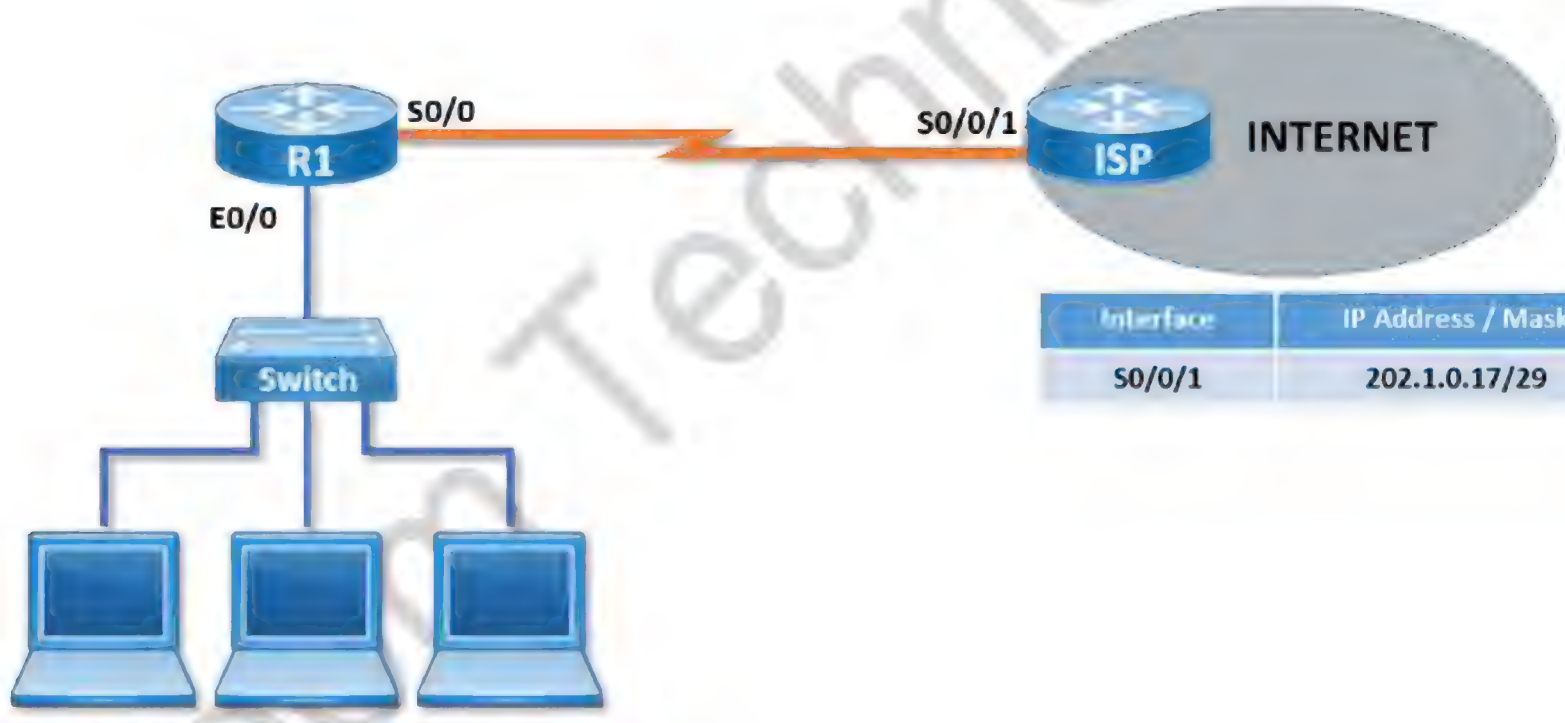
A network associate is configuring a router for the XYZ company to provide internet access. The ISP has provided the company 4 public IP addresses from 202.1.0.19 201.1.0.22. The company has 14 hosts that need to access the internet simultaneously. The hosts in the company LAN have been assigned private space addresses in the range of 192.168.2.17 – 192.168.2.30.

The following has already been configured on the router :

- The basic router configuration
- The appropriate interfaces have been configured for NAT inside and NAT outside
- The appropriate static routes have also been configured
- All passwords have been temporarily set to "cisco"

Topology:

Connectivity and IP address for the lab are as below:



Interface	IP Address / Mask
S0/0/1	202.1.0.17/29

Interface	IP Address / Mask
E0/0	192.168.2.1/24
S0/0	202.1.0.18/29

NAT – SOLUTION

Verify Existing R1 Configuration

```
R1 # show running-config
Using 791 bytes
!
version 15.1
no service timestamps log datetime msec
no service timestamps debug datetime msec
no service password-encryption
!
hostname R1
!
enable password cisco
!
interface Ethernet0/0
 ip address 192.168.2.1 255.255.255.0
ip nat inside
 duplex auto
 speed auto
!
!
interface Serial0/0/0
 ip address 202.1.0.18 255.255.255.248
ip nat outside
!
ip route 0.0.0.0 0.0.0.0 Serial0/0/0
!
line con 0
!
line aux 0
!
line vty 0 4
 password zoom
 login
!
!
!
end
```

The XYZ company has 14 hosts that need to access the internet simultaneously but we just have 4 public IP addresses from 202.1.0.19 to 202.1.0.22/29. So we need to configure NAT overload (or PAT).

Create a NAT pool of global addresses to be allocated with their netmask. i.e. /29 = 255.255.255.248

R1 (config) # **ip nat pool mypool 202.1.0.19 202.1.0.22 netmask 255.255.255.248**

Create a standard access control list that permits the addresses that are to be translated

R1 (config) # **access-list 1 permit 192.168.2.16 0.0.0.15**

Establish dynamic source translation, specifying the access list that was defined in the prior step

R1 (config) # **ip nat inside source list 1 pool mypool overload**

This command translates all source addresses that match the**access list 1** i.e. source address from **192.168.2.17 to 192.168.2.30**, into an address from the pool named **mypool** i.e. the pool of ip addresses from **202.1.0.19 to 202.1.0.122**. **Overload** keyword allows mapping multiple IP addresses to a single registered IP address (many-to-one) by using different ports

Verify NAT inside and NAT outside statements are configured on correct interfaces.

R1 (config)# **interface E0/0**
R1 (config-if)# **ip nat inside**
R1 (config-if)# **exit**
R1 (config)# **interface S0/0**
R1 (config-if)# **ip nat outside**
R1 (config-if)# **exit**

Save the configuration using below command

R1# **copy running-config startup-config**

Verify configuration from a Computer:

ping 202.1.0.17

The ping should work and you should get reply packets.

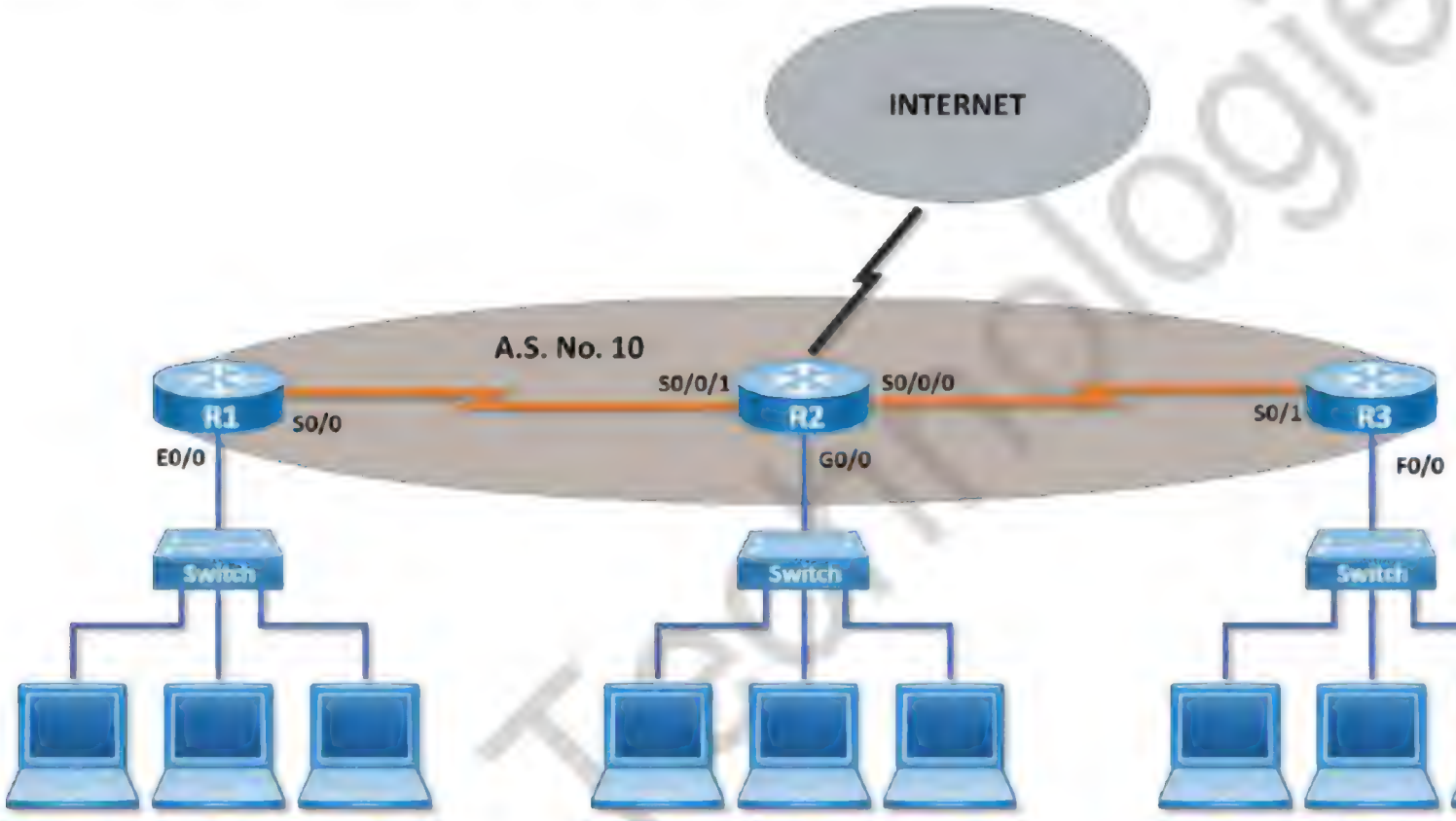
EIGRP – QUESTION

After adding R3 router, no routing updates are being exchanged between R2 and the new location. All other inter connectivity and Internet access for the existing locations of the company are working properly.

The task is to identify the fault(s) and correct the router configuration to provide full connectivity between the routers. All passwords on all routers are "cisco"

Topology:

Connectivity and IP address for the lab are as below :



Interface	IP Address / Mask
E0/0	192.168.2.1/24
S0/0	172.16.0.1/16

Interface	IP Address / Mask
G0/0	10.0.0.1/8
S0/0/0	172.17.0.1/16
S0/0/1	172.16.0.2/16

Interface	IP Address / Mask
F0/0	192.168.3.1/24
S0/1	172.17.0.2/16

EIGRP – SOLUTION

Verify Existing R1 Configuration

R1 # **show running-config**
R1#sh running-config
Building configuration...

Current configuration : 837 bytes
!
version 15.1
no service timestamps log datetime msec
no service timestamps debug datetime msec
no service password-encryption
!
hostname R1
!
<output omitted>
!
interface Ethernet0/0
 ip address 192.168.2.1 255.255.255.0
 duplex auto
 speed auto
!
interface Serial0
 ip address 172.16.0.1 255.255.0.0
 clock rate 64000
!
router eigrp 10
 network 172.16.0.0
 network 192.168.2.0
 no auto-summary
!
<output omitted>
!
!
end

Verify Existing R2 Configuration

R2 # **sh running-config**
Building configuration...

Current configuration : 868 bytes
!
version 15.1
no service timestamps log datetime msec
no service timestamps debug datetime msec
no service password-encryption
!
hostname R2

```
!
<output omitted>
!
!
interface GigabitEthernet0/0
 ip address 10.0.0.1 255.0.0.0
 duplex auto
 speed auto
!
interface Serial0/0/0
 ip address 172.16.0.2 255.255.0.0
!
interface Serial0/0/1
 ip address 172.17.0.1 255.255.0.0
 clock rate 64000
!
router eigrp 10
 passive-interface Serial0/0/1
 network 10.0.0.0
 network 172.16.0.0
 no auto-summary
!
<output omitted>
!
end
```

Verify Existing R3 Configuration

R3 # **sh running-config**
Building configuration...

```
Current configuration: 819 bytes
!
version 15.1
no service timestamps log datetime msec
no service timestamps debug datetime msec
no service password-encryption
!
!
hostname R3
!
<output omitted>
!
interface GigabitEthernet0/0
 ip address 192.168.3.1 255.255.255.0
 duplex auto
 speed auto
!
interface Serial0/0/0
 ip address 172.17.0.2 255.255.0.0
!
router eigrp 11
```

```
 network 192.168.3.0
 network 172.17.0.0
 no auto-summary
!
ip classless
!
<output omitted>
!
end
```

From the above outputs, we now know that router **R3** is wrongly configured with an **AS No. 11** and all other routers are configured with **AS No. 10**. Whenever the AS numbers among routers are mismatched, no adjacency is formed.

To resolve this issue, simply re-configure EIGRP commands on router R3 :

R3 >**enable**
R3 # **configure terminal**
R3 (config)# **no router eigrp 11**
R3 (config)#**router eigrp 10**
R3 (config-router)# **network 192.168.3.0**
R3 (config-router)# **network 172.17.0.0**
R3 (config-router)# **no auto-summary**
R3 (config-router)# **end**

Save the configuration using the command below

R3# **copy running-config startup-config**

From the R2 output, we had found out 2 issues

- All networks on R2 are not advertised in EIGRP configuration.
- passive-interface command given for the interface connected to R3 router

Advertise Missing Networks in EIGRP Configuration

R2 >**enable**
R2 # **configure terminal**
R2 (config)# **router eigrp 10**
R2 (config-router)# **network 172.17.0.0**
R2 (config-router) # **end**

Disable Passive Interface command for interface connected to R3 router

R2 (config) # **router eigrp 10**
R2 (config-router) # **no passive-interface serial 0/0/1**
R2 (config-router) # **end**

Save the configuration using below command

R2 # **copy running-config startup-config**

Check the routing table on R3. You should now be able to see all the routes.

MCSE-2012 Full Course

MICROSOFT CERTIFIED SOLUTIONS EXPERT

Practicals in real-time environment. Detailed curriculum with all 5 papers

Duration: 1 Month | 4 Hrs Per Day (starts on 15th & 30th of every month)

Batches: Morning: 8.30 to 10.30 • Afternoon: 2.00 to 4.00 • Evening: 7.30 to 9.30

CCNA (v 2.0) Full Course

CISCO CERTIFIED NETWORK ASSOCIATE

Cisco Routers with BSNL/TELCO MUX & Live Channelised E1

Duration: 1 Month | 4 Hrs Per Day (starts on 15th & 30th of every month)

Batches: Morning: 8.30 to 10.30 • Afternoon: 2.00 to 4.00 • Evening: 7.30 to 9.30

LINUX ADMINISTRATION

COMPLETE RHCE LINUX

Practicals on Live Web Administration + Integration of Windows with Linux/Unix (Samba Server)

Duration: 2 Weeks | 4 Hrs Per Day (starts on 15th & 30th of every month)

Batches: Morning: 8.00 • Afternoon: 1.30 • Evening: 7.00

PC HARDWARE & NETWORKING

WORKSHOP ON EMERGING TECHNOLOGIES

- Ethical Hacking, Cyber Security and Firewall
- Open Source: A glimpse into advance Linux
- VMware vSphere and MS Private Cloude
- Cisco WAN Technology & Collaboration

Free MCSE & CCNA Exam Practice Questions

Complete Package for Only

Fees: ₹ 5,900/-

+ 14% Service Tax

Duration: 3 Months
4 Hrs Per Day

100% GUARANTEED JOB ASSISTANCE

EHCE | Ethical Hacking & Countermeasures Expert

Course is mapped to EHCE course from US-Council (www.us-council.com)

(Pre requisite is CCNA / MCSE / LINUX)

Duration: 2 Weeks | 4 Hrs Per Day (starts on 15th & 30th of every month)

Batches: Morning: 7.30 or Evening: 6.00

Fees: ₹ 9,500/-
+ 14% Service Tax

CCNP R&S

CISCO CERTIFIED NETWORK PROFESSIONAL

Duration: 1 Month | 4 Hrs Per Day (starts on 15th of every month)

Batches: Morning: 7.30 • Afternoon: 2.00 • Evening: 6.00

- Labs on latest routers with IOS version 15.X

Monitoring, Diagnostics & Troubleshooting Tools

• PRTG • Wireshark • SolarWinds, etc.

Exam Practice Challenge Labs

Fees: ~~₹ 10,000/-~~

Introductory Special Offer

Fees: ₹ 5,500/-

+ 14% Service Tax

CCIE R&S

CISCO CERTIFIED INTERNETWORK EXPERT

Duration: 1 Month | 4 Hrs Per Day (starts on 15th of every month)

Batches: Morning: 7.30 • Evening: 6.00

- Individual Rack For Every Student
- Real time scenarios by 20+ years experienced CCIE certified industry expert who has worked on critical projects worldwide.

Written + Lab Exam Focus

FREE Full Scale 8 Hours Exam Lab Included

Unlimited Lab Access For 1 Year

Fees: ~~₹ 25,000/-~~

Introductory Special Offer

Fees: ₹ 9,999/-

+ 14% Service Tax

MICROSOFT EXCHANGE SERVER-2013

Duration: 2 Weeks | 4 Hrs Per Day (starts on 15th & 30th of every month)
Batches: (Contact the Counselors for the next available batch)

Fees: ₹ 2,500/-
+ 14% Service Tax

MICROSOFT PRIVATE CLOUD

Microsoft Certified Solutions Expert [MCSE] Private Cloud
Duration: 2 Weeks | 4 Hrs Per Day
Batches: (Contact the Counselors for the next available batch)

Fees: 2,500/-
+ 14% Service Tax

ADVANCED LINUX

Duration: 2 Weeks | 4 Hrs Per Day (starts on 15th & 30th of every month)
Batches: (Contact the Counselors for the next available batch)

Fees: ₹ 2,500/-
+ 14% Service Tax

CCNA SECURITY (Pre requisite is CCNA R&S)

CISCO CERTIFIED NETWORK ASSOCIATE - SECURITY
Duration: 2 Weeks | 4 Hrs Per Day (starts on 15th of every month)
Batches: Morning: 7.30 or Evening: 6.00

Fees: ₹ 7,500/-
+ 14% Service Tax

CCNP SECURITY (Pre requisite is CCNA Security at ZOOM)

CISCO CERTIFIED NETWORK PROFESSIONAL - SECURITY
Duration: 2 Weeks | 4 Hrs Per Day (starts on 30th of every month)
Batches: Morning: 7.30 or Evening: 6.00

Fees: ₹ 9,500/-
+ 14% Service Tax

CCIE SECURITY (Pre requisite is CCNA & CCNP Security at ZOOM)

CISCO CERTIFIED INTERNETWORK - SECURITY
Duration: 1 Month | 4 Hrs Per Day
Batches: (Contact the Counselors for the next available batch)

Fees: ₹ 15,500/-
+ 14% Service Tax

VMware vSphere (Pre requisite is MCSE)

Duration: 1 Month | 4 Hrs Per Day (starts on 15th of every month)
Batches: Morning: 7.30 and Evening: 7.30

Fees: ₹ 4,950/-
+ 14% Service Tax

VMware vCloud (Pre requisite is VMware vSphere)

Duration: 1 Week | 4 Hrs Per Day (starts on 15th of every month)
Batches: Morning: 9.30 to 11.30

Fees: ₹ 2,500/-
+ 14% Service Tax

CHECKPOINT FIREWALL

Duration: 2 Weeks | 4 Hrs Per Day
Batches: (Contact the Counselors for the next available batch)

Fees: ₹ 5,500/-
+ 14% Service Tax

We also offer the following courses (Contact the Counselors for the next available batch)

- **CCNA Voice** @ ₹7,500/-
- **CCNP Voice** @ ₹9,500/-
- **CCIE Collaboration** @ ₹15,500/-
- **CCNA Data Center** @ ₹7,500/-
- **CCNP Data Center** @ ₹9,500/-
- **CCIE Data Center** @ ₹15,500/-
- **IPv6 Migration** @ ₹5,500/-

FACULTY

- All Senior Engineers of Zoom working on Live projects
- Training Engineers of British Army, CISCO, CMC, GE, BSNL, Tata Teleservices and Several Corporates etc for 18 Years.

FREE Training

Zoom Technologies offers a number of free resources for the professional development of network engineers.

Register on our website to get access to the video recordings of live sessions on:

- **MCSE – Windows Server 2012**
- **Cisco – CCNA**
- **Cisco – CCNP** } **All Tracks (R & S, Security and Voice)**
- **Cisco – CCIE**
- **Exchange Server 2013**
- **Linux**
- **Advanced Linux** } **All Flavors**
- **Ethical Hacking and Countermeasure Expert (www.us-council.com)**

Find us at: www.zoomgroup.com

Like us on Facebook and get access to free online webinars as well as special offers and discounts. **https://www.facebook.com/ZoomTechnolgies**

Online Training

Online Training at Zoom is a cost effective method of learning new networking skills from the convenience of your home or workplace.

Taking an online training course has many advantages for everyone (Freshers / Working Professionals). Zoom offers online training for the highly coveted CCNA, CCNP and CCIE courses as well as MCSE, Linux, VMware, Ethical Hacking and Firewalls, IPv6 with more courses planned for the near future. These are live instructor led courses, using Cisco WebEX. Check out our online course offerings at: **http://zoomgroup.com/online_course**

Job Opportunities

There is a high demand for network and security professionals at all times. Apart from job opportunities in India and the Middle East, network and security administrators are also sought-after in the US and Europe.

If you do not have the right skills, then get them now! Choose the experts in network and security training, an organization which has already trained over one hundred thousand engineers.

For the latest job openings in networking and security, register and upload your resume on: **http://zoomgroup.com/careers** or visit zoom to choose job offering from several multinational companies.

ABOUT US

ZOOM Technologies India Pvt. Ltd. is a pioneering leader in network and security training, having trained over a hundred thousand engineers over the last two decades.

We offer a world class learning environment, with state-of-the-art labs which are fully equipped with high-end routers, firewalls, servers and switches. All our courses are hands-on so you'll get much needed practical experience.

The difference between us and the competition can be summed up in one simple sentence. Our instructors are real-time network professionals who also teach.

Zoom has designed, developed and provided network and security solutions as well as training to all the big names in the Indian industry, for the public sector as well as corporate leaders. Some of our clients are:

TATA
BSNL
VSNL
Indian Railways
National Police Academy
Air Force Academy
IPCL- Reliance Corporation
CMC
British Army

No other training institute can boast of a customer base like this. This is the reason for the resounding success of our networking courses. If you do not have the right skills, then get them now. Come, join the experts!

Training Centers in Hyderabad, India.

Banjara Hills

HDFC Bank Building, 2nd Floor,
Road # 12, Banjara Hills,
Hyderabad - 500 034
Telangana,
India.

Phone: +91 40 23394150
Email: banjara@zoomgroup.com

Ameerpet

203, 2nd Floor,
HUDA Maitrivanam, Ameerpet,
Hyderabad - 500 016
Telangana,
India.

Phone: +91 40 39185252
Email: ameerpet@zoomgroup.com

Secunderabad

Navketan Building,
5 Floor, # 501
Secunderabad - 500 003
Telangana,
India.

Phone: +91 40 27802461
Email: mktg@zoomgroup.com

Dilsukhnagar

Ist Floor, # 16-11-477/B/1&B/2,
Shlivahana Nagar, Dilsukhnagar,
Hyderabad - 500 060
Telangana,
India.

Phone: +91-40-24140011
Email: dsnr@zoomgroup.com

website: www.zoomgroup.com